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PEDCo-Environmental, Inc, Cincinnati, OH

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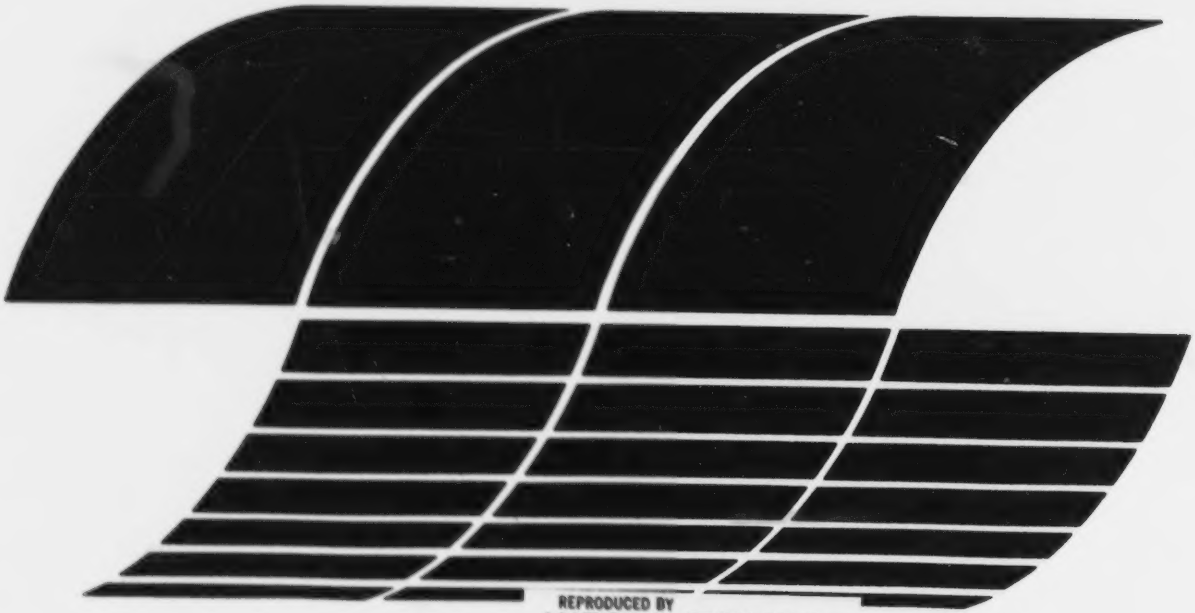

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16. ABSTRACT The report gives detailed technical information concerning application of flue gas desulfurization (FGD) systems to industrial boilers. Design and operation data is presented for 172 FGD control systems (132 of them operational), designed to control SO2 emissions from 206 industrial boilers at 61 plants. With a 1978 capacity of 9.2 million scfm, an average of more than seven new FGD systems have been put on line each year since 1972. Information in the report was obtained by a survey of plant personnel, control system vendors, regulatory agencies, and consulting engineering firms. The data is given in two types of tables: one gives summary information; the other, detailed information. Summary tables present information as a function of control process, control system vendor, disposal technique, operational status, startup date, and flue gas capacity. Detailed information includes: control system design, economics, operating experience, problems and solutions, waste disposal techniques, and maintenance practices.

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NOTICE

This report (prepared by PEDCo Environmental, Inc., Cincinnati, Ohio under EPA Contract No. 68-02-2603, Task No. 45) is provided as an information transfer document. Data in this report are supplied voluntarily by industrial representatives; flue gas desulfurization (FGD) system designers, vendors, and suppliers; regulatory personnel; and others. Neither EPA nor the designated contractor warrants the accuracy or completeness of information contained in this report.

Initial distribution of the report is limited to organization and individuals indicating a specific interest in the field of FGD technology. Additional copies of this report and succeeding issues can be purchased from National Technical Information Service, Springfield, Virginia 22151.

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EXECUTIVE SUMMARY

THE FIRST FULL-SCALE UNITED STATES APPLICATION OF FLUE GAS DESULFURIZATION (FGD) TECHNOLOGY TO INDUSTRIAL BOILERS WAS AT THE GENERAL MOTORS PLANT IN ST. LOUIS, MISSOURI WHERE TWO FGD SYSTEMS WERE INSTALLED ON TWO COAL-FIRED BOILERS IN 1972. IN THIS 4TH QUARTER 1978 REPORT, 132 OPERATIONAL FGD SYSTEMS ARE DESCRIBED. THESE SYSTEMS ARE CONTROLLING SO2 EMISSIONS FROM 206 BOILERS, LOCATED AT 39 PLANT SITES ACROSS THE UNITED STATES. FGD SYSTEMS AT 22 PLANTS ARE KNOWN TO BE UNDER CONSTRUCTION OR IN SOME STAGE OF PLANNING. IN ADDITION THERE ARE 7 INSTALLATIONS INCLUDED IN THE REPORT WHERE FGD OPERATIONS HAVE EITHER BEEN TERMINATED, INDEFFINITELY SHUT DOWN, OR NEVER STARTED-UP. THE TOTAL COVERAGE OF THIS REPORT IS THEREFORE 68 INSTALLATIONS. TABLE 1 SUMMARIZES THE NUMBER AND SCFM OF THOSE SYSTEMS OPERATING, UNDER CONSTRUCTION, OR IN SOME PLANNING PHASE.

TABLE I
NUMBER AND SCFM OF INDUSTRIAL BOILER FGD SYSTEMS

STATUS	NO. OF INSTALLATIONS	CAPACITY SCFM	NO. OF SEPERATE FGD SYSTEMS	NO. OF BOILERS CONTROLLED
OPERATIONAL	39	5,486,530	132	206
UNDER CONSTRUCTION	11	1,235,500	27	69
PLANNING*				
CONTRACT AWARDED	4	177,000	5	7
LETTER OF INTENT	0	0	0	0
REQUESTING/EVALUATING BIDS	2	286,000	4	14
CONSIDERING USING FGD	5	1,924,000	8	16
TOTAL	61	9,109,030	172	312

*NOTE: THERE ARE PROBABLY SEVERAL FGD SYSTEMS BEING PLANNED WHICH HAVE NOT BEEN LOCATED BY THIS SURVEY AND THEREFORE ARE NOT COVERED IN THIS REPORT.

TABLE 2 SUMMARIZES THE PLANTS ACCORDING TO THE YEAR OF FGD STARTUP, AND THE SCFM CAPACITY.

HIGHLIGHTS FROM THE CURRENT INDUSTRIAL BOILER SURVEY ARE GIVEN BELOW:

CATERPILLAR TRACTOR CO. REPORTED THE FOLLOWING ITEMS:

EAST PEORIA - THE BOILER CAN OBTAIN NO MORE THAN 80% LOAD BECAUSE FAN CAPACITY IS NOT GREAT ENOUGH TO OVERCOME AN ABNORMALLY HIGH PRESSURE DROP IN THE SCRUBBERS. FAN AND DRAFT TESTS ARE BEING RUN TO PINPOINT THE PROBLEM AREA.

MAPLETON - CONSTRUCTION HAS BEEN COMPLETED ON THREE BOILERS AND THE FMC DOUBLE ALKALI FGD SYSTEMS AND START-UP IS EXPECTED IN LATE DECEMBER OR EARLY JANUARY 1979. INSTALLATION HAS JUST BEGUN ON TWO ADDITIONAL BOILERS SCHEDULED FOR START-UP IN 1980.

CATERPILLAR TRACTOR CO. (CONTINUED)

MORTON - ACCEPTANCE TESTING WAS COMPLETED THIS QUARTER AND AN APPLICATION HAS BEEN SUBMITTED TO THE STATE FOR A STATE PERMIT TO OPERATE. PLANT PERSONNEL FEEL THEY WILL RECEIVE THE FIRST SUCH A PERMIT IN ILLINOIS TO BURN HIGH SULFUR COAL IN AN INDUSTRIAL BOILER.

TABLE 2
STARTUP YEAR AND SCFM OF INDUSTRIAL BOILER FGD SYSTEMS

YEAR	UNITS	SCFM
1972	1	64,000
1973	4	635,300
1974	5	431,400
1975	12	1,480,300
1976	6	1,024,530
1977	4	346,000
1978	7	1,505,000
1979	13	1,187,500
1980	3	371,000
1982	2	460,000
1984	1	1,200,000
1987	1	280,000
YEAR NOT YET DETERMINED	2	124,000
TOTAL	61	9,109,030

CHEVRON U.S.A., INC. REPORTED SYSTEM AVAILABILITY INDEX FOR THE QUARTER WAS 100%.

GENERAL MOTORS REPORTED THAT MODIFICATIONS WERE MADE TO TWO GM FGD SYSTEMS:

PARMA - NEW FRP STACKS WERE INSTALLED ATOP THE SCRUBBER MODULES, AND THE TOPS OF THE MODULES WERE RECONSTRUCTED TO REDUCE THE GAS VELOCITY. THE ORIGINAL STAINLESS STEEL STACKS WERE BADLY CORRODED.

DAYTON - THE ENTOLETER "VANE CAGE" SCRUBBERS WERE RECONSTRUCTED DURING THE REPORT PERIOD. THE INTERMEDIATE SECTIONS WERE REMOVED, AND NEW HASTELLOY-G 2-STAGE RADIAL VANE MIST ELIMINATORS WERE INSTALLED.

GETTY OIL HAS BEGUN OPERATING FIVE OUT OF A TOTAL OF NINE IN-HOUSE DESIGN FGD SYSTEMS, AT GETTY'S ENHANCED OIL RECOVERY OPERATION NEAR BAKERSFIELD, CALIFORNIA. OF THE FOUR REMAINING UNITS TO BE STARTED UP, TWO ARE SCHEDULED TO START IN MID-JANUARY AND TWO IN MID-FEBRUARY 1979. ONE SYSTEM IS USING SODIUM HYDROXIDE SCRUBBING IN AN ATTEMPT TO EVALUATE THE PERFORMANCE OF CAUSTIC COMPARED TO SODA ASH AS THE ALKALI.

THE U.S. AIR FORCE HAS AWARDED TO AIRPOL INDUSTRIES THE FGD SYSTEM CONTRACT FOR THE HEAT PLANT AT **GRISSOM AIR FORCE BASE** IN BUNKER HILL, INDIANA. THE SYSTEM WILL CONTROL 32,000 SCFM, FOR COAL WITH A SULFUR CONTENT RANGING FROM 0.9 TO 4.6%, AT A DESIGN RATE OF 1.2 LBS OF SO2/MM BTU HEAT INPUT.

ITT RAYONIER, INC. REPORTED THAT THE BOILER AND THE AIRPOL FGD SYSTEMS OPERATED APPROXIMATELY 95% OF THE PERIOD. THE ONLY OUTAGE DURING THE PERIOD WAS A 3-DAY DOWNTIME THAT WAS BOILER-RELATED.

KERR-MCGEE SODA ASH PLANT, UTILIZING A COMBUSTION EQUIPMENT ASSOCIATES DESIGN FOR SO2 REMOVAL, REPORTED THAT BOTH SCRUBBERS DEMONSTRATED 100% RELIABILITY FOR THIS QUARTER.

MEAD PAPERBOARD CO. REPORTED AN AVAILABILITY INDEX VALUE OF 100% FOR THIS AIRPOL FGD SYSTEM FOR THE QUARTER.

PHILIP MORRIS, INC. IS INSTALLING A FLAKT INC. SODIUM CARBONATE FGD SYSTEM AT THEIR TOBACCO REPROCESSING PLANT IN CHESTERFIELD, VIRGINIA. THE SYSTEM WILL INCLUDE A 6 GPM QUENCHER, A 3-STAGE FRP SPRAY TOWER, A POLYPROPYLENE CHEVRON MIST ELIMINATOR, A SODA ASH STORAGE TANK AND AN OXIDATION TOWER. THE SCRUBBER IS DESIGNED TO HANDLE 39,000 SCFM, OR 2/3 OF THE FLUE GAS FROM A NEW 500,000 LB/HR PULVERIZED COAL-FIRED BOILER. THE REMAINING 1/3 OF THE GAS WILL BE USED FOR REHEAT. START-UP IS SCHEDULED FOR JUNE 1979.

RICKENBACKER AIR FORCE BASE REPORTED THEIR RESEARCH-COTTRELL/BAHCO SCRUBBER TO HAVE AN FGD SYSTEM AVAILABILITY INDEX OF APPROXIMATELY 98% FOR THE QUARTER.

AT THE **ST. JOE ZINC CO.** FGD SYSTEM CONSTRUCTION IS NEARING COMPLETETION; THE BUREAU OF MINES CITRATE PROCESS SYSTEM IS NOW SCHEDULED TO START-UP IN MARCH 1979.

AT THE **WESTERN CORRECTIONAL INSTITUTION** IN PITTSBURG, THE SCORE (SULF-X CONCURRENT OXIDES REMOVAL) PROCESS, DEVELOPED BY PITTSBURG ENVIRONMENTAL AND ENERGY SYSTEMS, INC. IS BEING INSTALLED. SIMULTANEOUS REMOVAL OF SO2 (90%) AND NOX (60%) WILL BE ACHIEVED. EMISSIONS CONTROL IS SCHEDULED TO BEGIN IN MAY 1979 AND THE REGENERATION LOOP (ELEMENTAL SULFUR BY-PRODUCT) IS SLATED TO BEGIN IN THE LATE FALL OF 1979.

OF THE MORE THAN 170 ACTIVE (OPERATING, UNDER CONSTRUCTION, OR PLANNED) FGD UNITS ADDRESSED IN THIS REPORT, MORE THAN HALF ARE BEING USED OR SCHEDULED TO BE USED IN ENHANCED OIL RECOVERY (EOR) SITES IN CALIFORNIA. BECAUSE OF THE FACT THESE UNITS PREDOMINATE IN THIS REPORT, A BRIEF DISCUSSION OF THE EOR INDUSTRY FOLLOWS.

IN 1976, THE SAN JOAQUIN VALLEY AIR BASIN PRODUCED ABOUT 45% OF CALIFORNIA'S CRUDE OIL OUTPUT. EOR OPERATIONS ACCOUNTED FOR ABOUT 50% OF THAT PRODUCTION. ADDITIONALLY, EOR OPERATIONS IN THE BASIN ACCOUNTED FOR APPROXIMATELY 80% OF CALIFORNIA'S TOTAL EOR OPERATIONS.

THE MOST COMMON MEANS OF PRODUCING CRUDE OIL RELIES ON NATURAL UNDERGROUND PRESSURE TO PUSH THE OIL TO THE SURFACE OF A WELL. IF NATURAL PRESSURE IS LACKING, PUMPS ARE USED TO PULL THE OIL OUT OF AN OIL RESERVOIR. THESE METHODS OF PRODUCING CRUDE OIL ARE TERMED PRIMARY RECOVERY. IF WATER IS PUMPED INTO AN OIL RESERVOIR (SECONDARY RECOVERY), CRUDE RECOVERY CAN BE INCREASED OR "ENHANCED". WHEN THE CAPABILITIES OF THE PRIMARY AND THE SECONDARY METHODS ARE EXHAUSTED, ADDITIONAL ENHANCED RECOVERY (TERTIARY RECOVERY) METHODS ARE CONSIDERED. TERTIARY OIL RECOVERY EMPLOYS THERMAL MEANS TO MAKE HEAVY, VISCOUS CRUDE OILS MOVE THROUGH SAND AND ROCK STRATA MORE EASILY.

TYPICALLY STEAM IS INJECTED CONTINUOUSLY TO FLOOD THE UNDERGROUND OIL RESERVOIR WITH STEAM AND HOT WATER. THERE ARE CURRENTLY ABOUT 800 STEAM GENERATORS (TYPICAL STEAM QUALITY IS 80 PERCENT) IN THE SAN JOAQUIN BASIN AND MOST OF THESE UNITS HAVE CAPACITIES IN THE RANGE OF 15 MM BTU/HR TO 65 MM BTU/HR. STEAM GENERATORS IN THIS SIZE RANGE VARY FROM ABOUT 5,000 TO 30,000 ACFM @ APPROXIMATELY 600 F.

THE CALIFORNIA AIR RESOURCES BOARD (CARB) HAS PROPOSED REGULATIONS WHICH WOULD REQUIRE THE FOLLOWING FOR OIL-FIRED STEAM GENERATORS:

SOURCE	SO2 EMISSION LIMIT	NOX EMISSION LIMIT
NEW GENERATORS	60 PPM	100 PPM
EXISTING GENERATORS	200 PPM	150 PPM

THIS REPORT ADDRESSES IN DETAIL FGD OPERATIONS FOR THOSE EOR PRODUCTION COMPANIES WHO HAVE GIVEN PERMISSION. THOSE COMPANIES ARE AS FOLLOWS:

BELRIDGE OIL COMPANY
CHANSLOR WESTERN OIL AND DEVELOPMENT COMPANY
CHEVRON U.S.A., INC.
GETTY OIL COMPANY
MOBIL OIL COMPANY
SHELL OIL COMPANY
SUN PRODUCTION COMPANY
TENNECO OIL COMAPNY
TEXACO, INC.

IN SECTION 2 OF THIS REPORT (BEGINNING ON PAGE 3) THE READER CAN FIND A DETAILED INDEX TO INFORMATION ON THE ABOVE INSTALLATIONS.

SECTION 1

INTRODUCTION

THIS REPORT ADDRESSES THE APPLICATION OF FLUE GAS DESULFURIZATION (FGD) TECHNOLOGY TO INDUSTRIAL BOILERS. AN INDUSTRIAL BOILER WILL BE DEFINED AS A BOILER OR STEAM GENERATOR WHICH IS OPERATING OR SCHEDULED FOR OPERATION AT AN INDUSTRIAL SITE. THIS IS IN CONTRAST TO A UTILITY BOILER WHEREIN THE PRIME FUNCTION IS STEAM GENERATION AND SUBSEQUENT CONVERSION TO ELECTRICAL POWER FOR SALE TO THE PUBLIC. THE NEED FOR SUCH A DOCUMENT HAS ARISEN AS A RESULT OF MORE STRINGENT EMISSION REGULATIONS DESIGNED TO REDUCE SULFUR DIOXIDE (SO2) EMISSIONS. IN VIEW OF THE DEVELOPMENTAL STATUS OF FGD TECHNOLOGY, EPA'S INDUSTRIAL ENVIRONMENTAL RESEARCH LABORATORY IN RESEARCH TRIANGLE PARK, NORTH CAROLINA, HAS ESTABLISHED THIS PERIODICALLY UPDATED ENGINEERING APPLICATION/INFORMATION TRANSFER PROGRAM FOR INDUSTRIAL USE OF SO2 CONTROL TECHNOLOGY.

FIRST ISSUED IN DECEMBER 1977 AS A COMPREHENSIVE 900-PAGE REPORT ON SO2 CONTROL SYSTEMS ON ALL NON-UTILITY COMBUSTION AND PROCESS SOURCES, THE CURRENT SERIES, IN THE INTEREST OF ECONOMIZING OPERATIONS, ADDRESSES ONLY INDUSTRIAL BOILER APPLICATIONS OF FGD TECHNOLOGY. THE FIRST ISSUE OF THIS SERIES, ENTITLED "EPA INDUSTRIAL BOILER FGD SURVEY: FIRST QUARTER 1978," PRESENTED DETAILED TECHNICAL INFORMATION ON INDUSTRIAL BOILER FGD INSTALLATIONS. THE INFORMATION WAS OBTAINED BY A SURVEY OF PLANT PERSONNEL, CONTROL SYSTEM VENDORS, REGULATORY AGENCIES, AND ENGINEERING FIRMS.

THE CURRENT REPORT REPRESENTS AN EXPANSION OVER THE THIRD QUARTER 1978 ISSUE WITH RESPECT TO BOTH THE NUMBER OF INSTALLATIONS, AND THE INFORMATION PRESENTED FOR EACH INSTALLATION. THE DATA ARE GIVEN IN TWO TYPES OF TABLES: ONE GIVES SUMMARY INFORMATION; THE OTHER DETAILED INFORMATION. SUMMARY TABLES PRESENT INFORMATION AS FUNCTIONS OF TYPE OF CONTROL PROCESS, CONTROL SYSTEM VENDOR, DISPOSAL TECHNIQUES AND OPERATIONAL STATUS (OPERATIONAL, UNDER CONSTRUCTION, PLANNED, OR NOT OPERATING). NUMBERS, OPERATIONAL STATUS, AND OVERALL CAPACITY OF THE FGD SYSTEMS ARE SUMMARIZED IN THE EXECUTIVE SUMMARY. DETAILED INFORMATION INCLUDES: CONTROL SYSTEM DESIGN PARAMETERS, OPERATING EXPERIENCE, ECONOMICS, PROBLEMS AND SOLUTIONS, WASTE DISPOSAL TECHNIQUES, AND MAINTENANCE PRACTICES.

THE INFORMATION IN THIS REPORT WILL BE PERIODICALLY UPDATED AND EXPANDED BY MEANS OF TELEPHONE AND MAIL SURVEYS, AND PUBLISHED EACH QUARTER. IN FUTURE ISSUES, THE DATA BASE ON SELECTED PLANTS WILL BE EXPANDED BY ON-SITE SURVEYS.

CERTAIN ENGINEERING SYMBOLS AND TERMS ARE USED VERY FREQUENTLY IN THE FIELD OF FGD TECHNOLOGY. TABULATED BELOW ARE THE DEFINITIONS OF PERTINENT SYMBOLS AND TERMS USED IN THIS REPORT.

SYMBOL/TERM	DEFINITION
ACF	ACTUAL CUBIC FEET, UNIT OF GAS VOLUME MEASURED AT ITS ACTUAL TEMPERATURE AND PRESSURE
ACFM	ACTUAL CUBIC FEET PER MINUTE, UNIT OF GAS FLOW RATE MEASURED AT ITS ACTUAL TEMPERATURE AND PRESSURE
AVAILABILITY	HOURS THE FGD SYSTEM WAS AVAILABLE (WHETHER OPERATED OR NOT) DIVIDED BY HOURS IN PERIOD, EXPRESSED AS PERCENTAGE
CS	CARBON STEEL
F	DEGREES FARENHEIT, UNIT OF TEMPERATURE

DEFINITIONS (CONTINUED)

SYMBOL/TERM	DEFINITION
F.D.	FORCED DRAFT
FRP	FIBERGLASS-REINFORCED POLYESTER (OR PLASTIC)
GAL	GALLONS
GPM	GALLONS PER MINUTE
I.D.	INDUCED DRAFT
L/G	LIQUID-TO-GAS RATIO, RECIRCULATING LIQUID FLOW DIVIDED BY THE ACTUAL GAS FLOW, GAL/1000 ACF
MM	MILLION (DOLLARS, GALLONS, BTU, ETC.)
MS	MILD STEEL
MW(EQUIVALENT)	2000 SCFM/MW IS THE CONVERSION FACTOR USED FOR THIS REPORT. ALTHOUGH THERE ARE SEVERAL METHODS IN USE FOR ARRIVING AT EQUIVALENT MW, SUCH AS LB/HR OF STEAM, MM BTU/HR OF HEAT INPUT, THE FACTOR MOST INFLUENTIAL IN AFFECTING EQUIPMENT SIZING IS FLOW RATE. THIS CONVERSION ALLOWS FOR EASY COMPARISON BETWEEN THESE INDUSTRIAL FGD SYSTEMS AND THE UTILITY FGD SYSTEMS.
OPERABILITY	HOURS THE FGD SYSTEM OPERATED DIVIDED BY BOILER OPERATING HOURS IN PERIOD, EXPRESSED AS PERCENTAGE
PSIG	POUNDS PER SQUARE INCH, UNIT OF PRESSURE, AS COMPARED TO ATMOSPHERIC PRESSURE OF 14.7 PSI.
RELIABILITY	HOURS THE FGD SYSTEM WAS OPERATED DIVIDED BY HOURS IT WAS CALLED UPON TO OPERATE, EXPRESSED AS PERCENTAGE
SCFM	STANDARD CUBIC FEET PER MINUTE, UNIT OF GAS FLOW RATE MEASURED AT 70 F AND 1 ATM. PRESSURE IF THE PRESSURE IS ASSUMED TO BE ONE ATMOSPHERE, THEN THE FOLLOWING RELATION EXISTS: SCFM = ACFM(460 + 70)/(460 + ACTUAL TEMP)
SS	STAINLESS STEEL
T	TEMPERATURE
W.G.	WATER GAUGE, PRESSURE DROP EXPRESSED AS INCHES OF WATER (ATMOSPHERIC = 407 IN.)
0/XX	SYMBOL USED WHEN THE MONTH OF A STARTUP DATE IS NOT AVAILABLE
0/0	SYMBOL USED WHEN NEITHER THE MONTH NOR THE YEAR OF A STARTUP DATE IS AVAILABLE

THE ENGLISH SYSTEM IS USED IN THIS REPORT. SOME OF THE CONVERSION FIGURES BETWEEN THE ENGLISH AND METRIC SYSTEMS AND ABBREVIATIONS ARE SHOWN BELOW:

1 F (FOOT) = 0.3048 METER

1 T (SHORT TON) = 0.91 METRIC TON

1 LB (POUND) = 0.45 KILOGRAM

1 GAL (GALLON) = 3.79 LITER

1 BBL (BARREL) = 0.16 KILOLITER

1 SCFM = 1.58 NORMAL CUBIC METERS PER HOUR

1 GALLON/1000 ACF = 0.135 LITERS/NORMAL CUBIC METER

1 BTU = 0.25 KCAL

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SECTION 2

STATUS OF INDUSTRIAL BOILERS WITH FGD SYSTEMS

INSTALLATION NAME	LOCATION	START-UP DATE	STATUS*	PAGE NUMBER+
ALYESKA PIPELINE SERVICE CO.	VALDEZ, ALASKA	6-77	1	28(6,16,19,27,157)
AMERICAN THREAD CO.	MARION, NORTH CAROLINA	0-73	1	31(6,18,19,25,157)
ARCO/POLYMERS, INC.	MONACA, PENNSYLVANIA	6-80	2	116(6,16,22,24,157)
ARMCO STEEL	MIDDLETOWN, OHIO	0-75	1	33(6,18,19,25,157)
BELRIDGE OIL CO.	MCKITTRICK, CALIFORNIA	1-79	2	118(6,16,22, 0,157)
BELRIDGE OIL CO.	MCKITTRICK, CALIFORNIA	6-78	1	36(6,17,19,27,158)
BELRIDGE OIL CO.	MCKITTRICK, CALIFORNIA	7-78	1	38(6,18,19,27,158)
BUNGE, INC.	CAIRO, ILLINOIS	9-77	8	149(7,16, 0,24,158)
C.A.M.(CARBIDE-AMOCO-MONSANTO)	HOUSTON, TEXAS	0-84	6	136(7,18,23,27, 0)
CANTON TEXTILES	CANTON, GEORGIA	6-74	1	40(7,16,19,25,158)
CARBORUNDUM ABRASIVES	BUFFALO, NEW YORK	0-80	3	137(7,16,23,27, 0)
CATERPILLAR TRACTOR CO.	EAST PEORIA, ILLINOIS	4-78	1	42(7,17,19,24,159)
CATERPILLAR TRACTOR CO.	JOLIET, ILLINOIS	9-74	1	44(7,18,19,24,159)
CATERPILLAR TRACTOR CO.	MAPLETON, ILLINOIS	1-79	2	120(7,17,22,24,159)
CATERPILLAR TRACTOR CO.	MAPLETON, ILLINOIS	1-80	3	139(8,17,23,24, 0)
CATERPILLAR TRACTOR CO.	MORTON, ILLINOIS	1-78	1	46(8,18,19,24,159)
CATERPILLAR TRACTOR CO.	MOSSVILLE, ILLINOIS	10-75	1	48(8,17,19,24,159)
CHANSLOR WESTERN OIL & DEV. CO	BAKERSFIELD, CALIFORNIA	3-79	2	122(8,17,22,24,160)
CHEVRON U.S.A. INC.	BAKERSFIELD, CALIFORNIA	7-78	1	51(8,18,19,26,160)
CHEVRON U.S.A. INC.	BAKERSFIELD, CALIFORNIA	4-79	5	140(8,18,23,27, 0)
DUPONT, INC.	GEORGIA	0-87	6	141(8,18,23,24, 0)
DUPONT, INC.	TEXAS	0-82	6	142(9,18,23,24, 0)
FIRESTONE TIRE AND RUBBER CO.	POTTSTOWN, PENNSYLVANIA	1-75	1	53(9,17,19,24,160)
FMC (SODA ASH PLANT)	GREEN RIVER, WYOMING	5-76	1	57(9,17,19,25,160)
GENERAL MOTORS CORPORATION	DAYTON, OHIO	9-74	1	59(9,16,20,25,161)
GENERAL MOTORS CORPORATION	PARMA, OHIO	3-74	1	62(9,17,20,24,161)
GENERAL MOTORS CORPORATION	PONTIAC, MICHIGAN	4-76	1	69(9,17,20,24,161)
GENERAL MOTORS CORPORATION	ST. LOUIS, MISSOURI	0-72	1	71(9,16,20,25,161)

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SECTION 2 (CONTINUED)

STATUS OF INDUSTRIAL BOILERS WITH FGD SYSTEMS

INSTALLATION NAME	LOCATION	START-UP DATE	STATUS*	PAGE NUMBER+
GENERAL MOTORS CORPORATION	TONAWANDA, NEW YORK	6-75	1	73(10,17,20,24,161)
GEORGIA-PACIFIC PAPER CO.	CROSSETT, ARKANSAS	7-75	1	75(10,16,20,25,162)
GETTY OIL COMPANY	BAKERSFIELD, CALIFORNIA	6-77	1	77(10,17,20,25,162)
GETTY OIL COMPANY	BAKERSFIELD, CALIFORNIA	12-78	1	80(10,18,20,26,162)
GETTY OIL COMPANY	BAKERSFIELD, CALIFORNIA	1-79	2	124(10,18,22,26,162)
GREAT SOUTHERN PAPER CO.	CEDAR SPRINGS, GEORGIA	0-75	1	82(10,16,20,26,163)
GREAT WESTERN SUGAR	BILLINGS, MONTANA	10-77	1	84(11,17,20,26,163)
GREAT WESTERN SUGAR	FORT MORGAN, COLORADO	10-76	1	85(11,17,20,26,163)
GREAT WESTERN SUGAR	GERING, NEBRASKA	10-75	1	86(11,17,20,26,163)
GREAT WESTERN SUGAR	GREELEY, COLORADO	10-75	1	87(11,17,20,26,163)
GREAT WESTERN SUGAR	LONGMONT, COLORADO	10-73	7	150(11,17, 0,26,164)
GREAT WESTERN SUGAR	LOVELAND, COLORADO	10-73	1	88(11,17,21,26,164)
GREAT WESTERN SUGAR	SCOTTS BLUFF, NEBRASKA	10-75	1	89(11,17,21,26,164)
GRISSOM AIR FORCE BASE	BUNKER HILL, INDIANA	9-79	3	143(12,16,23,24, 0)
HARRIS MINING CO.	SPRUCE PINE, NORTH CAROLINA	0-73	8	151(12,18, 0,27,164)
ITT RAYONIER, INC.	FERNANDINA BEACH, FLORIDA	0-75	1	90(12,16,21,26,164)
KERR-MCGEE CHEMICAL CORP.	TRONA, CALIFORNIA	6-78	1	92(12,16,21,25,165)
MEAD PAPERBOARD CO.	STEVENSON, ALABAMA	0-75	1	95(12,16,21,24,165)
MINN-DAK FARMER'S CO-OPERATIVE	WAHPETON, NORTH DAKOTA	6-77	1	98(12,16,21,27,165)
MOBIL OIL COMPANY	BUTTONWILLOW, CALIFORNIA	2-79	2	125(12,17,22,25,166)
MOBIL OIL COMPANY	SAN ARDO, CALIFORNIA	0-74	1	100(13,18,21,25,166)
NEKOOSA PAPERS, INC.	ASHDOWN, ARKANSAS	2-76	1	102(13,16,21,24,166)
NORTHERN OHIO SUGAR COMPANY	FINDLAY, OHIO	10-74	7	152(13,17, 0,26,166)
NORTHERN OHIO SUGAR COMPANY	FREEMONT, OHIO	10-75	1	105(13,17,21,26,167)
PHILLIP MORRIS, INC.	CHESTERFIELD, VIRGINIA	6-79	2	127(13,16,22, 0,167)
RICKENBACKER AIR FORCE BASE	COLUMBUS, OHIO	3-76	1	106(13,18,21,25,167)
SHELL OIL COMPANY	BAKERSFIELD, CALIFORNIA	0- 0	6	145(13,18,23,27, 0)
SHELL OIL COMPANY	TAFT, CALIFORNIA	0- 0	6	146(14,18,23,27, 0)

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SECTION 2 (CONTINUED)

STATUS OF INDUSTRIAL BOILERS WITH FGD SYSTEMS

INSTALLATION NAME	LOCATION	START-UP DATE	STATUS*	PAGE NUMBER+
SHELLER GLOBE CORP.	NORFOLK, VIRGINIA	0-75	8	153(14,18, 0,27,167)
ST. JOE ZINC CO.	MONACA, PENNSYLVANIA	3-79	2	129(14,16,22,25,168)
ST. REGIS PAPER CO.	CANTONMENT, FLORIDA	0-73	1	110(14,16,21,27,168)
SUN PRODUCTION COMPANY	FELLOWS, CALIFORNIA	4-79	2	132(14,16,22,25,168)
SUN PRODUCTION COMPANY	OILDALE, CALIFORNIA	4-79	2	133(14,16,22,25,168)
TENNECO OIL CO.	GREEN RIVER, WYOMING	1-82	5	147(14,18,23,25, 0)
TEXACO INCORPORATED	SAN ARDO, CALIFORNIA	11-73	1	112(15,16,21,27,169)
TEXACO INCORPORATED	SAN ARDO, CALIFORNIA	3-79	2	134(15,16,22,27,169)
TEXASGULF	GRANGER, WYOMING	9-76	1	114(15,18,21,27,169)
TRANSCO TEXTILES, INC.	AUGUSTA, GEORGIA	3-75	8	155(15,17, 0,26,169)
U.S. GYPSUM CORP.	OAKMONT, PENNSYLVANIA	0- 0	9	156(15,16, 0,24,169)
WESTERN CORRECTIONAL INST.	PITTSBURG, PENNSYLVANIA	11-79	3	148(15,18,23, 0, 0)

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SECTION 3

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	BACKGROUND AND SUMMARY OF RECENT OPERATIONS
ALYESKA PIPELINE SERVICE CO. VALDEZ, ALASKA FMC ENVIRONMENTAL EQUIPMENT OIL (0.03% - 0.1% SULFUR) 50,000 SCFM (DESIGN MAXIMUM) START-UP 6/77 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	*BKGD: THE ALEYSKA FGD SYSTEM IS UNIQUE IN THAT IT WAS NOT INSTALLED PRIMARILY FOR CONTROL OF EMISSIONS, BUT TO TREAT GAS USED IN THE OIL STORAGE TANKS. *4TH QTR 78: FGD OPERATIONS FOR THIS REPORT PERIOD WERE PROBLEM FREE. CYCLOHEXYLAMINE IS NOW BEING SPRAYED INTO THE FLUE GAS EXITING THE SCRUBBER. THIS RAISES THE PH OF THE CARRY-OVER BETWEEN 6 AND 7 AND HAS APPARENTLY STOPPED THE CORROSION INSIDE THE MILD STEEL OIL STORAGE TANKS.
AMERICAN THREAD CO. MARION, NORTH CAROLINA W.W. SLY MANUFACTURING CO. COAL (1 - 1.5% SULFUR) 18,500 SCFM (TOTAL - 2 BOILERS) START-UP 0/73 CAUSTIC WASTE STREAM STATUS - OPERATIONAL	*BKGD: AMERICAN THREAD IN MARION, NORTH CAROLINA USES A CAUSTIC SCRUBBING APPROACH TO CONTROL PARTICULATE AND SO2 EMISSIONS FROM TWO COAL-FIRED BOILERS. *4TH QTR 78: THE PLANT REPORTED NO OPERATING PROBLEMS CONCERNING THE RECIRCULATION TANKS OR PUMPS. PATCH-UP WORK ON THE FAN ROTOR LINING AND REPLACEMENT OF 4 SPRAY NOZZLES CAUSED TWO DAYS OF DOWNTIME.
ARCO/POLYMERS, INC. MONACA, PENNSYLVANIA FMC ENVIRONMENTAL EQUIPMENT COAL (3.0% SULFUR) 236,000 SCFM (TOTAL - 3 BOILERS) START-UP 6/80 DOUBLE ALKALI (CONCENTRATED) STATUS - CONSTRUCTION	*BKGD: ARCO/POLYMERS HAS AWARDED A CONTRACT TO FMC ENVIRONMENTAL EQUIPMENT DIVISION FOR A DOUBLE ALKALI FGD SYSTEM. THE SYSTEM WILL CONSIST OF A SEPARATE SCRUBBER TRAIN FOR EACH OF THE THREE IDENTICAL BOILERS. EACH ABSORBER MODULE WILL HAVE FOUR DISC-AND-DONUT TRAYS AND BE FOLLOWED BY A CHEVRON MIST ELIMINATOR. *4TH QTR 78: CONSTRUCTION OF THE FGD SYSTEM BEGAN IN SEPTEMBER 1978.
ARMCO STEEL MIDDLETOWN, OHIO KOCH ENGINEERING COAL (0.8% SULFUR) 84,000 SCFM (TOTAL - 2 BOILERS) START-UP 0/75 LIME SCRUBBING STATUS - OPERATIONAL	*BKGD: THIS CONTROL SYSTEM SERVES TWO MULTI-RETORT UNDERFEED STOKER, COAL-FIRED BOILERS EACH WITH A CAPACITY OF 100,000 LBS/HR STEAM. *4TH QTR 78: ABRASION IS A CONTINUING PROBLEM. FIBERGLASS PIPING HAS BEEN INSTALLED IN SOME LOCATIONS. NO OTHER INFORMATION HAS BEEN MADE AVAILABLE DUE TO THE POSSIBILITY OF LITIGATION CONCERNING NEW EMISSION STANDARDS.
BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA HEATER TECHNOLOGY OIL (1.1% SULFUR) 12,000 SCFM (1 BOILER) START-UP 6/78 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	*BKGD: BELRIDGE IS UTILIZING A HEATER TECHNOLOGY FGD SYSTEM TO CONTROL SO2 EMISSIONS FROM A SMALL OIL-FIRED (1.1% SULFUR) STEAM GENERATOR AT AN ENHANCED OIL RECOVERY SITE. *4TH QTR 78: AN AVAILABILITY OF 89% WAS DEMONSTRATED THIS QUARTER. SEVERE VIBRATIONS IN THE RECIRCULATION PUMP CAUSED THE RECIRCULATION PIPING TO FAIL. CAUSTIC LINE LEAKS WERE REPAIRED.
BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA THERMOTICS INC. CRUDE OIL (1.1% SULFUR) 12,000 SCFM START-UP 7/78 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	*BKGD: BELRIDGE IS UTILIZING A THERMOTICS, INC. FGD SYSTEM TO CONTROL SO2 EMISSIONS FROM A SMALL OIL-FIRED (1.1% SULFUR) STEAM GENERATOR AT THE MCKITTRICK ENHANCED OIL RECOVERY SITE. *4TH QTR 78: DURING THIS QUARTER, THE SCRUBBER EXHIBITED AN AVAILABILITY INDEX OF 93%. ELECTRICAL MALFUNCTIONS AND A LEAK IN THE CAUSTIC FEED LINE WERE MAJOR PROBLEMS. A SEAL ON THE RECIRCULATION PUMP REQUIRED REPLACEMENT.
BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA C-E NATCO CRUDE OIL (1.1% SULFUR) 12,000 SCFM START-UP 1/79 SODIUM HYDROXIDE SCRUBBING STATUS - CONSTRUCTION	*4TH QTR 78: CONSTRUCTION OF A C-E NATCO FGD SYSTEM INSTALLED ON A SMALL OIL-FIRED STEAM GENERATOR, IS NEARING COMPLETION. THE ORIGINAL START-UP DATE OF NOVEMBER 1978 HAS BEEN DELAYED UNTIL EARLY JANUARY 1979.

SECTION 3 (CONTINUED)

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	BACKGROUND AND SUMMARY OF RECENT OPERATIONS
BUNGE, INC. CAIRO, ILLINOIS DRAVO CORP./NAT'L LIME ASS'N COAL (3% SULFUR) 44,000 SCFM (TOTAL - 2 BOILERS) START-UP 9/77 LIME SCRUBBING STATUS - INDEFFINITELY SHUT DOWN	*BKGD: BUNGE PURCHASED THIS LIME SYSTEM FOR TESTING PURPOSES. THE PLANT REPORTS THAT THE LEWIS SCRUBBER, A HORIZONTAL ROTARY SCRUBBER WITH INTERNAL CHAINS, PERFORMED WELL DURING THE TEST, EFFECTING 94% SO2 CONTROL. *4TH QTR 78: BUNGE IS STILL FIRING LOW SULFUR (0.9%) COAL AND HAS NO PLANS TO REUSE THE SYSTEM.
C.A.M.(CARBIDE-AMOCO-MONSANTO) HOUSTON, TEXAS VENDOR NOT YET SELECTED FUEL NOT YET SELECTED 1,200,000 SCFM (1 BOILER) START-UP 0/84 PROCESS NOT YET SELECTED STATUS - PLANNED-CONSIDERING SO2 CONTROL	*BKGD: UNION CARBIDE, AMOCO, AND MONSANTO HAVE ENTERED INTO A JOINT VENTURE (C.A.M.) WHICH WILL PRODUCE 3,000,000 LB/HR STEAM FOR PROCESS USE AND 100 MW ELECTRICITY TO THE LOCAL UTILITY GRID. *4TH QTR 78: AFTER THE SELECTION OF A CONTROL SYSTEM IN EARLY 1979, CONSTRUCTION WILL START EARLY IN 1980 WITH SCHEDULED COMPLETION IN 1984.
CANTON TEXTILES CANTON, GEORGIA FMC ENVIRONMENTAL EQUIPMENT COAL (0.8% SULFUR) 25,000 SCFM (1 BOILER) START-UP 6/74 CAUSTIC WASTE STREAM STATUS - OPERATIONAL	*BKGD: AT CANTON TEXTILES THE CONTROL SYSTEM CONSISTS OF AN FMC MEDIUM ENERGY VENTURI SCRUBBER AND UTILIZES A CAUSTIC WASTE STREAM FOR SO2 REMOVAL. THE UNIT HAS BEEN IN OPERATION SINCE JUNE 1974. *4TH QTR 78: THE PLANT REPORTED THAT COAL FIRING RESUMED IN MID-OCTOBER 1978. THE BUILD-UP OF FLYASH IN THE SCRUBBER CAUSED 10 HOURS DOWNTIME. THE SCRUBBER OPERATED AT A 99+% RELIABILITY INDEX.
CARBORUNDUM ABRASIVES BUFFALO, NEW YORK CARBORUNDUM ENVIR. SYS. LTD. COAL (2.2% SULFUR) 30,000 SCFM (TOTAL - 2 BOILERS) START-UP 0/80 LIME SCRUBBING STATUS - PLANNED-CONTRACT AWARDED	*BKGD: THE CARBORUNDUM FGD SYSTEM CONSISTS OF A VENTURI FOR PARTICULATE CONTROL FOLLOWED BY A SIX-STAGE SPRAY TOWER. IN 1975 THE VENTURI WAS PUT INTO SERVICE USING WATER ONLY. THE HIGH CHLORIDES CONTENT OF THE FLUE GAS CAUSED SERIOUS CORROSION PROBLEMS, AND BOTH THE VENTURI AND THE SPRAY TOWER WILL BE REPLACED BEFORE START-UP OF THE COMPLETE LIME SCRUBBING SYSTEM IN 1980. THE NEW VENTURI AND SPRAY TOWER WILL BE MADE OF HASTELLOY-C AND FRP, RESPECTIVELY.
CATERPILLAR TRACTOR CO. EAST PEORIA, ILLINOIS FMC ENVIRONMENTAL EQUIPMENT COAL (3.2% SULFUR) 210,000 SCFM (TOTAL - 4 BOILERS) START-UP 4/78 DOUBLE ALKALI (CONCENTRATED) STATUS - OPERATIONAL	*BKGD: START-UP OCCURRED IN APRIL 1978. FGD OPERATIONS PROCEEDED FOR 30 DAYS BEFORE BOILER PLANT SHUTDOWN FOR THE SUMMER. AN ABNORMALLY HIGH PRESSURE DROP THROUGH THE SCRUBBERS IS RESTRICTING THE BOILERS TO ABOUT 80% OF THEIR CAPACITY. *4TH QTR 78: FAN AND DRAFT TESTS WERE RUN IN DECEMBER TO PINPOINT THE LOCATION OF THE HIGH PRESSURE DROP. THIS FURTHER DELAYED EMISSION TESTS.
CATERPILLAR TRACTOR CO. JOLIET, ILLINOIS ZURN INDUSTRIES COAL (3.2% SULFUR) 67,000 SCFM (TOTAL - 2 BOILERS) START-UP 9/74 DOUBLE ALKALI (DILUTE) STATUS - OPERATIONAL	*BKGD: THE FGD SYSTEM CONSISTS OF AN INDEPENDENT SCRUBBING TRAIN ON EACH OF TWO COAL-FIRED BOILERS. *4TH QTR 78: FILTER CLOTH WEAR CONTINUES TO BE A PROBLEM. THE HASTELLOY-C SO2 PROBES REQUIRE CONTINUING MAINTENANCE. FLYASH ACCUMULATION IN THE BOTTOMS OF THE GUILLOTINE DAMPERS IS STILL A PROBLEM.
CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS FMC ENVIRONMENTAL EQUIPMENT COAL (3.2% SULFUR) 131,000 SCFM (TOTAL - 3 BOILERS) START-UP 1/79 DOUBLE ALKALI (CONCENTRATED) STATUS - CONSTRUCTION	*BKGD: AT THE CATERPILLAR MAPLETON PLANT, FMC CONCENTRATED MODE DUAL ALKALI TECHNOLOGY WILL BE UTILIZED TO CONTROL SO2 EMISSIONS. *4TH QTR 78: THREE SCRUBBERS ARE SLATED FOR START-UP IN JANUARY 1979. DELAY OF THE START-UP DATE FROM OCTOBER 1978 WAS A RESULT OF CONSTRUCTION ACTIVITY AND NOT THE INSTALLATION OF SPECIAL DESIGN MODIFICATIONS.

SECTION 3 (CONTINUED)

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	BACKGROUND AND SUMMARY OF RECENT OPERATIONS
CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS FMC ENVIRONMENTAL EQUIPMENT COAL (3.2% SULFUR) 105,000 SCFM (TOTAL - 2 BOILERS) START-UP 1/80 DOUBLE ALKALI (CONCENTRATED) STATUS - PLANNED-CONTRACT AWARDED	*4TH QTR 78: AT THE MAPLETON PLANT, AN ADDITIONAL 2 NEW BOILERS ARE PLANNED FOR START-UP IN THE EARLY 1980'S. INSTALLATION FOR THESE TWO ARE JUST NOW BEGINNING. THEY WILL EACH BE EQUIPPED WITH FMC DOUBLE ALKALAI FGD SYSTEMS. THEY WILL SHARE REGENERATION AND SLUDGE HANDLING FACILITIES WITH THE OTHER THREE FGD SYSTEMS AT THIS SITE.
CATERPILLAR TRACTOR CO. MORTON, ILLINOIS ZURN INDUSTRIES COAL (3.2% SULFUR) 38,000 SCFM (TOTAL - 2 BOILERS) START-UP 1/78 DOUBLE ALKALI (DILUTE) STATUS - OPERATIONAL	*BKGD: THE CATERPILLAR MORTON PLANT UTILIZES ZURN INDUSTRIES' DILUTE MODE DOUBLE ALKALI TECHNOLOGY TO CONTROL EMISSIONS FROM THE STEAM PLANT. *4TH QTR 78: THE PUFFING PROBLEM HAS BEEN SOLVED BY MODIFYING THE INTERNALS OF THE SCRUBBERS. PH IS SAMPLED HOURLY WITH MULTIBAND LITMUS PAPER. ACCEPTANCE TESTING HAS BEEN COMPLETED AND AN APPLICATION HAS BEEN SUBMITTED TO THE STATE FOR A PERMIT TO OPERATE.
CATERPILLAR TRACTOR CO. MOSSVILLE, ILLINOIS FMC ENVIRONMENTAL EQUIPMENT COAL (3.2% SULFUR) 140,000 SCFM (TOTAL - 4 BOILERS) START-UP 10/75 DOUBLE ALKALI (CONCENTRATED) STATUS - OPERATIONAL	*BKGD: THE CATERPILLAR MOSSVILLE PLANT HAS UTILIZED FMC CONCENTRATED MODE FGD SYSTEM EACH HEATING SEASON SINCE OCTOBER 1975. THERE ARE FOUR COAL-FIRED BOILERS, EACH POSSESSING A SEPARATE SCRUBBING TRAIN. *4TH QTR 78: EROSION OF VALVES, FITTINGS, LININGS, PUMPS, FANS AND SCRUBBER NOZZLES IS A SIGNIFICANT PROBLEM. AN EMISSIONS TEST IS SCHEDULED FOR LATE JANUARY OR EARLY FEBRUARY.
CHANSLOR WESTERN OIL & DEV. CO BAKERSFIELD, CALIFORNIA FMC ENVIRONMENTAL EQUIPMENT OIL (1.5% SULFUR) 70,000 SCFM (TOTAL - 8 BOILERS) START-UP 3/79 DOUBLE ALKALI (CONCENTRATED) STATUS - CONSTRUCTION	*BKGD: CHANSLOR WESTERN HAS PURCHASED A DOUBLE ALKALI FGD SYSTEM FROM FMC. *4TH QTR 78: CONSTRUCTION IS NEARING COMPLETION, BUT THE ORIGINAL START-UP SCHEDULED FOR DECEMBER 1978 HAS BEEN EXTENDED TO MARCH 1979 DUE TO ADDITIONAL ELECTRICAL WORK AND EQUIPMENT INSTALLATION.
CHEVRON U.S.A. INC. BAKERSFIELD, CALIFORNIA KOCH ENGINEERING OIL (1.1% SULFUR) 248,000 SCFM (TOTAL - 18 BOILERS) START-UP 7/78 SODIUM CARBONATE SCRUBBING STATUS - OPERATIONAL	*BKGD: CHEVRON U.S.A. UTILIZES THREE KOCH ENGINEERING ABSORBERS TO REMOVE SO2 FROM THE FLUE GAS OF EIGHTEEN BOILERS. THE SYSTEMS ARE DESIGNED TO REDUCE SO2 EMISSIONS TO LESS THAN 70 PPM. *4TH QTR 78: THE FGD SYSTEM OPERATED PROBLEM-FREE DURING THE QUARTER DEMONSTRATING AN AVAILABILITY INDEX OF 100%.
CHEVRON U.S.A. INC. BAKERSFIELD, CALIFORNIA KOCH ENGINEERING OIL (1.1% SULFUR) 146,000 SCFM (TOTAL - 12 BOILERS) START-UP 4/79 SODIUM CARBONATE SCRUBBING STATUS - PLANNED-REQUESTING/EVALUATING BIDS	*4TH QTR 78: CHEVRON U.S.A. IS PLANNING TO INSTALL TWO MORE FGD SYSTEMS AT THE BAKERSFIELD OIL SITE. THESE WILL BE ONCE-THROUGH, SODIUM CARBONATE SCRUBBING SYSTEMS AND ARE SCHEDULED TO GO ON-STREAM BY APRIL 1979. A CONTRACT HAS BEEN AWARDED TO KOCH ENGINEERING FOR THE DESIGN AND INSTALLATION OF THE TWO SYSTEMS. CONSTRUCTION IS SCHEDULED TO BEGIN IN JANUARY 1979.
DUPONT, INC. GEORGIA VENDOR NOT YET SELECTED COAL (1.5% SULFUR) 280,000 SCFM (TOTAL - 3 BOILERS) START-UP 0/87 DOUBLE ALKALI STATUS - PLANNED-CONSIDERING SO2 CONTROL	*3RD QTR 78: DUPONT ANNOUNCED PLANS TO ERECT A COAL-FIRED BOILER AT AN AS YET UNSPECIFIED SITE IN GEORGIA. THE COMPANY HAS DECIDED UPON A DOUBLE ALKALI FGD STRATEGY TO CONTROL SO2 EMISSIONS FROM 3 COAL-FIRED BOILERS. START-UP IS SLATED FOR 1987.

SECTION 3 (CONTINUED)

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	BACKGROUND AND SUMMARY OF RECENT OPERATIONS
DUPONT, INC. TEXAS VENDOR NOT YET SELECTED COAL (0.5% SULFUR) 320,000 SCFM (TOTAL - 2 BOILERS) START-UP 0/82 LIMESTONE SCRUBBING STATUS - PLANNED-CONSIDERING SO2 CONTROL	*3RD QTR 78: DUPONT ANNOUNCED PLANS TO ERECT A COAL-FIRED BOILER AT AN AS YET UNSPECIFIED SITE IN TEXAS. THE COMPANY HAS DECIDED UPON A LIMESTONE FGD STRATEGY TO CONTROL SO2 EMISSIONS FROM 2 COAL-FIRED BOILERS. START-UP IS SLATED FOR 1982.
FIRESTONE TIRE AND RUBBER CO. POTTSTOWN, PENNSYLVANIA FMC ENVIRONMENTAL EQUIPMENT COAL (2.5 - 3.0% SULFUR) 8070 SCFM (13,000 ACFM @ 300 F) START-UP 1/75 DOUBLE ALKALI (CONCENTRATED) STATUS - OPERATIONAL	*BKGD: THE FGD SYSTEM AT FIRESTONE-POTTSTOWN CONSISTS OF AN FMC DOUBLE ALKALI DUAL THROAT VENTURI SCRUBBER. THIS CONTROL SYSTEM WAS BUILT AS A DEMONSTRATION PROJECT FUNDED BY FIRESTONE. *4TH QTR 78: THE SYSTEM OPERATED WITH A RELIABILITY INDEX VALUE OF 93.7% DURING THE PERIOD. A BROKEN BELT ON THE RECIRCULATION PUMP CAUSED 20 HOURS DOWNTIME.
FMC (SODA ASH PLANT) GREEN RIVER, WYOMING FMC ENVIRONMENTAL EQUIPMENT COAL (1% SULFUR) 446,000 SCFM (TOTAL - 2 BOILERS) START-UP 5/76 SODIUM CARBONATE SCRUBBING STATUS - OPERATIONAL	*BKGD: THE FGD SYSTEM CONSISTS OF TWO FMC SODIUM SCRUBBING UNITS TO REMOVE SULFUR DIOXIDE AND PARTICULATE MATTER FROM THE FLUE GAS OF TWO BOILERS. *4TH QTR 78: THE PLANT REPORTED NO MAJOR OPERATING PROBLEMS. DURING THIS REPORT PERIOD THE INDEX VALUE OF THE FGD SYSTEM WAS REPORTED TO BE CLOSE TO 100%.
GENERAL MOTORS CORPORATION DAYTON, OHIO ENTOLETER, INC. COAL(0.7% - 2.0% SULFUR) 36,000 SCFM (TOTAL - 2 BOILERS) START-UP 9/74 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	*BKGD: THE FGD SYSTEM CONSISTS OF TWO ENTOLETER SODIUM HYDROXIDE SCRUBBING UNITS TO CONTROL EMISSIONS FROM TWO 60,000 LB/HR COAL-FIRED BOILERS. *4TH QTR 78: NEW HASTELLOY-G MIST ELIMINATORS HAVE BEEN INSTALLED, REPLACING THE BADLY CORRODED STAINLESS UNITS. THE PHENOL LINING HAS FLAKED OFF AND WILL NOT BE REPLACED. WORK IS SCHEDULED TO BEGIN ON A NEW PH MONITORING SYSTEM IN JANUARY.
GENERAL MOTORS CORPORATION PARMA, OHIO GM ENVIRONMENTAL COAL (2.5% SULFUR) 128,400 SCFM (TOTAL - 4 BOILERS) START-UP 3/74 DOUBLE ALKALI (DILUTE) STATUS - OPERATIONAL	*BKGD: THE FGD SYSTEM CONSISTS OF 4 GM-DESIGNED DUAL ALKALI SCRUBBERS OPERATING ON 4 BOILERS. THE SCRUBBERS HANDLE A TOTAL 240,000 ACFM OF FLUE GAS. *4TH QTR 78: AN OPERABILITY OF 23.9% WAS REPORTED FOR THE PERIOD. THE CORRODED STAINLESS STEEL STACKS WERE REPLACED WITH CORTEN STEEL, AND THE TOPS OF THE ABSORBERS WERE MODIFIED TO REDUCE FLUE GAS VELOCITY ENTERING THE STACKS.
GENERAL MOTORS CORPORATION PONTIAC, MICHIGAN GM ENVIRONMENTAL COAL (0.84% SULFUR) 107,300 SCFM (TOTAL - 2 BOILERS) START-UP 4/76 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	*BKGD: THE SCRUBBER SYSTEM CONSISTS OF TWO G.M. SODIUM UNITS FOR THE REMOVAL OF FLYASH AND SULFUR DIOXIDE FROM THE FLUE GAS OF TWO COAL-FIRED BOILERS. *4TH QTR 78: PRESSURE FILTERS HAVE BEEN INSTALLED IN THE RECIRCULATION LINES TO PREVENT FURTHER ABRASION PROBLEMS IN PUMPS AND PIPING DUE TO FLYASH. TO DATE, THIS MODIFICATION HAS BEEN SUCCESSFUL.
GENERAL MOTORS CORPORATION ST. LOUIS, MISSOURI A.D. LITTLE COAL (3.2% SULFUR) 64,000 SCFM (TOTAL - 2 BOILERS) START-UP 0/72 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	*BKGD: THIS SO2 CONTROL SYSTEM CONSISTS OF TWO GM DESIGNED SODIUM SCRUBBING UNITS OPERABLE ON TWO OF THE FOUR COAL-FIRED BOILERS. THE SYSTEM IS EQUIPPED WITH 60 F REHEAT AND HAS THE CAPABILITY FOR FGD SYSTEM BYPASS. *4TH QTR 78: THE DUCTWORK DOWNSTREAM OF THE FGD SYSTEM WAS RECONSTRUCTED TO PREVENT STAGNATION OF THE EXHAUST GASES. CORROSION OF THE STEEL LINER REMAINS A PROBLEM.

SECTION 3 (CONTINUED)

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	BACKGROUND AND SUMMARY OF RECENT OPERATIONS
GENERAL MOTORS CORPORATION TONOWANDA, NEW YORK FMC ENVIRONMENTAL EQUIPMENT COAL (1.2% SULFUR) 92,000 SCFM (TOTAL - 4 BOILERS) START-UP 6/75 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	*BKGD: THE FGD SYSTEM CONSISTS OF FOUR GM SODIUM SCRUBBING UNITS FOR THE REMOVAL OF PARTICULATES AND SULFUR DIOXIDE FROM FOUR COAL-FIRED BOILERS. *4TH QTR 78: THE FOUR STAINLESS STEEL STUB STACKS HAVE CORRODED DUE TO ACID CARRY-OVER AND PLANS ARE BEING MADE TO EITHER RELINE OR REPLACE THEM. ALSO, CHEVRON MIST ELIMINATORS WILL BE INSTALLED TO REDUCE THE ENTRAINED LIQUID IN THE FLUE GAS.
GEORGIA-PACIFIC PAPER CO. CROSSETT, ARKANSAS AIRPOL INDUSTRIES BARK,COAL/OIL (1.5% - 2.0% SULFUR) 220,000 SCFM (1 BOILER) START-UP 7/75 CAUSTIC WASTE STREAM STATUS - OPERATIONAL	*BKGD: THE FGD SYSTEM CONSISTS OF AN AIRPOL CAUSTIC SCRUBBING UNIT TO REMOVE SULFUR DIOXIDE AND PARTICULATE MATTER FROM THE FLUE GAS OF A COAL/BARK OR OIL/BARK POWER BOILER. THE SYSTEM IS PRECEDED BY CYCLONES FOR PARTICULATE REMOVAL. *4TH QTR 78: THE PLANT REPORTED NO OPERATING PROBLEMS DURING THIS PERIOD.
GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA FMC ENVIRONMENTAL EQUIPMENT OIL (1.1% SULFUR) 72,000 SCFM (TOTAL - 6 BOILERS) START-UP 6/77 SODIUM CARBONATE SCRUBBING STATUS - OPERATIONAL	*4TH QTR 78: THE SODIUM CARBONATE SCRUBBING FGD SYSTEM SUPPLIED BY FMC IN JUNE 1977, HAS PERFORMED WELL DURING THE QUARTER. THE POSITIVE DISPLACEMENT MOYNO PUMP EXPERIENCED ABRASION ON THE ROTOR. ALLOYS SUCH AS CHROME-ALLOY AND NI-HARD ARE BEING REVIEWED AS REPLACEMENT MATERIAL.
GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA IN-HOUSE DESIGN OIL (1.1% SULFUR) 495,000 SCFM (TOTAL-45 BOILERS) START-UP 12/78 SODIUM CARBONATE SCRUBBING STATUS - OPERATIONAL	*BKGD: GETTY OIL COMPANY HAS DEVELOPED AN IN-HOUSE FGD PROCESS DESIGN AND PLANS TO UTILIZE THIS PROCESS TO CONTROL EMISSIONS FROM 81 STEAM GENERATORS, AT THE BAKERSFIELD EOR SITE. THERE WILL BE 9 FGD SYSTEMS, EACH CONTROLLING FLUE GAS GENERATED BY 9 STEAM GENERATORS. EACH SYSTEM WILL INCLUDE AN ABSORBER MODULE (PURCHASED FROM KOCH ENGINEERING) CONTAINING THREE FLEXIMESH TRAYS AND ONE FLEXIMESH MIST ELIMINATOR. THIS ENTRY ADDRESSES THE 5 FGD SYSTEMS WHICH HAVE STARTED. *4TH QTR 78: THE 5 SYSTEMS WHICH HAVE BEGUN OPERATING HAVE EXPERIENCED PROBLEMS WITH FANS, MIST ELIMINATORS, AND SCALING.
GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA IN-HOUSE DESIGN OIL (1.1% SULFUR) 396,000 SCFM (TOTAL-36 BOILERS) START-UP 1/79 SODIUM CARBONATE SCRUBBING STATUS - CONSTRUCTION	*BKGD: GETTY OIL HAS DEVELOPED AN IN-HOUSE FGD PROCESS DESIGN AND PLANS TO UTILIZE THIS PROCESS TO CONTROL EMISSIONS FROM 81 STEAM GENERATORS, AT THE BAKERSFIELD EOR SITE. THERE WILL BE 9 FGD SYSTEMS, EACH CONTROLLING FLUE GAS GENERATED BY 9 STEAM GENERATORS. THIS ENTRY ADDRESSES THE 4 FGD SYSTEMS NOT YET STARTED. *4TH QTR 78: OF THE 4 UNITS YET TO BEGIN OPERATING, 2 ARE SCHEDULED TO START IN MID-JANUARY AND 2 IN MID-FEBRUARY.
GREAT SOUTHERN PAPER CO. CEDAR SPRINGS, GEORGIA AIRPOL INDUSTRIES BARK,COAL/OIL (1.0% - 2.0% SULFUR) 420,000 SCFM (TOTAL - 2 BOILERS) START-UP 0/75 CAUSTIC WASTE STREAM STATUS - OPERATIONAL	*BKGD: THE FGD SYSTEM CONSISTS OF TWO AIRPOL CAUSTIC SCRUBBERS TO CONTROL PARTICULATE AND SULFUR DIOXIDE FROM TWO POWER BOILERS. THE PRIMARY FUEL IS BARK/COAL (BARK/OIL IS FIRED OCCASIONALLY). *4TH QTR 78: FAILURE OF SEALS AND PACKINGS IN PUMPS CONTINUED TO BE A PROBLEM. NEW SEALS WILL BE INSTALLED. RUBBER-LINED PIPING IS GRADUALLY BEING REPLACED WITH STAINLESS STEEL. PLANS ARE BEING MADE TO REDUCE THE SOLIDS CONTENT IN THE LIQUOR BY INCREASING THE BLEED-OFF.

SECTION 3 (CONTINUED)

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	BACKGROUND AND SUMMARY OF RECENT OPERATIONS
GREAT WESTERN SUGAR BILLINGS, MONTANA GREAT WESTERN SUGAR COAL (0.7% SULFUR) 60,000 SCFM (TOTAL - 3 BOILERS) START-UP 10/77 AMMONIA-LADEN PROCESS WATER STATUS - OPERATIONAL	*BKGD: GREAT WESTERN SUGAR USES CONDENSATE PROCESS WATER PRIMARILY FOR PARTICULATE CONTROL. THE WATER HAS A HIGH PH (8.7) BUT THE SYSTEM HAS A LOW SO2 REMOVAL BECAUSE THE WATER IS INTRODUCED THROUGH PIPES RATHER THAN SPRAY NOZZLES.
GREAT WESTERN SUGAR FORT MORGAN, COLORADO GREAT WESTERN SUGAR COAL (1.2% SULFUR, AVERAGE) 65,230 SCFM (TOTAL - 2 BOILERS) START-UP 10/76 AMMONIA-LADEN PROCESS WATER STATUS - OPERATIONAL	*BKGD: THE VENTURI SCRUBBER WAS DESIGNED FOR PARTICULATE CONTROL AND STARTED IN OCT. 76. THE CONDENSATE PROCESS WATER USED HAS A HIGH PH (8.7) WHICH REMOVES SOME SO2. THE PARTICULATE AND SO2 CONTROL EFFICIENCIES ARE 96% AND 48% RESPECTIVELY.
GREAT WESTERN SUGAR GERING, NEBRASKA GREAT WESTERN SUGAR COAL (1.2% SULFUR, AVERAGE) 110,000 SCFM (TOTAL - 2 BOILERS) START-UP 10/75 AMMONIA-LADEN PROCESS WATER STATUS - OPERATIONAL	*BKGD: GREAT WESTERN SUGAR USES CONDENSATE PROCESS WATER PRIMARILY FOR PARTICULATE CONTROL. THE WATER HAS A HIGH PH (8.7) BUT THE SYSTEM HAS A LOW SO2 REMOVAL. THE VENTURI SCRUBBERS WERE INSTALLED IN OCT. 75. THE PLANT OPERATES ONLY DURING THE FALL QUARTER.
GREAT WESTERN SUGAR GREELEY, COLORADO GREAT WESTERN SUGAR COAL (0.6% SULFUR) 25,000 SCFM (1 BOILER) START-UP 10/75 AMMONIA-LADEN PROCESS WATER STATUS - OPERATIONAL	*BKGD: GREAT WESTERN SUGAR USES CONDENSATE PROCESS WATER PRIMARILY FOR PARTICULATE CONTROL. THE WATER HAS A HIGH PH (8.7) BUT THE SYSTEM HAS A LOW SO2 REMOVAL BECAUSE THE WATER IS INTRODUCED THROUGH PIPES RATHER THAN SPRAY NOZZLES.
GREAT WESTERN SUGAR LONGMONT, COLORADO GREAT WESTERN SUGAR COAL (0.7% SULFUR) SCFM-N/A START-UP 10/73 AMMONIA-LADEN PROCESS WATER STATUS - TERMINATED	SUGAR PRODUCTION AND ALL PLANT OPERATIONS HAVE BEEN TERMINATED AT THE LONGMONT PLANT.
GREAT WESTERN SUGAR LOVELAND, COLORADO GREAT WESTERN SUGAR COAL (1.2% SULFUR, AVERAGE) 121,800 SCFM (TOTAL - 2 BOILERS) START-UP 10/73 AMMONIA-LADEN PROCESS WATER STATUS - OPERATIONAL	*BKGD: GREAT WESTERN SUGAR USES CONDENSATE PROCESS WATER PRIMARILY FOR PARTICULATE CONTROL. THE WATER HAS A HIGH PH (8.7) BUT THE SYSTEM HAS A LOW SO2 REMOVAL. THE SCRUBBERS WERE INSTALLED IN OCTOBER 1973. THE PLANT OPERATES ONLY DURING THE FALL QUARTER.
GREAT WESTERN SUGAR SCOTTS BLUFF, NEBRASKA GREAT WESTERN SUGAR COAL (1.2% SULFUR, AVERAGE) 65,230 SCFM (TOTAL - 2 BOILERS) START-UP 10/75 AMMONIA-LADEN PROCESS WATER STATUS - OPERATIONAL	*BKGD: THE PLANT OPERATES ONLY DURING THE FALL QUARTER OF EACH YEAR. THE VENTURI SCRUBBER WAS DESIGNED FOR PARTICULATE CONTROL AND WAS STARTED IN OCT. 75. THE PARTICULATE AND SO2 REMOVAL EFFICIENCIES ARE 95% AND 76% RESPECTIVELY. THE SO2 CONTROL IS CAUSED BY THE PROCESS CONDENSATE USED FOR SCRUBBING (PH=8.7).

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	BACKGROUND AND SUMMARY OF RECENT OPERATIONS
GRISSOM AIR FORCE BASE BUNKER HILL, INDIANA AIRPOL INDUSTRIES COAL (0.9% - 4.6% SULFUR) 32,000 SCFM (TOTAL - 3 BOILERS) START-UP 9/79 DOUBLE ALKALI (CONCENTRATED) STATUS - PLANNED-CONTRACT AWARDED	*4TH QTR 78: THE AIR FORCE HAS AWARDED A CONTRACT TO AIRPOL INDUSTRIES FOR A CONCENTRATED DOUBLE-ALKALI FGD SYSTEM TO CONTROL EMISSIONS FROM ONE NEW AND TWO EXISTING COAL-FIRED BOILERS. START-UP IS SCHEDULED FOR AUGUST 30, 1979. AIRPOL HAS GUARANTEED THAT EMISSIONS FROM THE SYSTEM WILL NOT EXCEED 1.2 LB/MM BTU SO2 OR 0.171 LB/MM BTU FOR PARTICULATE.
HARRIS MINING CO. SPRUCE PINE, NORTH CAROLINA W.W. SLY MANUFACTURING CO. COAL (0.8% SULFUR) 4,000 SCFM (TOTAL - 2 BOILERS) START-UP 0/73 WATER SCRUBBING (NA,NH3 OPTN.) STATUS - INDEFINITELY SHUT DOWN	*BKGD: THE FGD SYSTEM CONSISTS OF A W.W. SLY IMPINJET SCRUBBER CURRENTLY BEING USED STRICTLY AS A PARTICULATE CONTROL DEVICE. THE SYSTEM HAS THE CAPABILITY OF SCRUBBING WITH AMMONIA OR CAUSTIC IF SO2 CONTROL IS NECESSARY. HOWEVER, AS LONG AS CURRENT LOW-SULFUR COAL SUPPLIES LAST, THERE IS NO NEED FOR SO2 CONTROLS.
ITT RAYONIER, INC. FERNANDINA BEACH, FLORIDA AIRPOL INDUSTRIES BARK,OIL (2.0% - 2.5% SULFUR) 176,000 SCFM (TOTAL - 4 BOILERS) START-UP 0/75 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	*BKGD: AT FERNANDINA BEACH, ITT RAYONIER FIRES BARK AND OIL IN TWO OF THE FOUR PROCESS STEAM BOILERS. PARTICULATE AND SO2 EMISSIONS ARE CONTROLLED IN TWO AIRPOL SCRUBBING TRAINS. *4TH QTR 78: MODULE A WAS DOWN FOR TEN DAYS TO REPAIR THE CRACKED FOUNDATION OF THE FAN. AT THIS TIME THE PRECEDING DUST COLLECTOR WAS ALSO REPAIRED. NEW DUST COLLECTORS ARE SCHEDULED TO BE INSTALLED IN APRIL WHICH WILL HELP REDUCE EROSION PROBLEMS.
KERR-MCGEE CHEMICAL CORP. TRONA, CALIFORNIA COMBUSTION EQUIPMENT ASSOC. COKE/COAL/OIL (0.5% - 5.0% SULFUR) 490,000 SCFM (TOTAL - 2 BOILERS) START-UP 6/78 SODIUM CARBONATE SCRUBBING STATUS - OPERATIONAL	*BKGD: THE FGD SYSTEM CONSISTS OF A COMBUSTION EQUIPMENT (CEA) SODA ASH SCRUBBING SYSTEM WHICH REMOVES FLYASH AND SULFUR DIOXIDE FROM THE FLUE GAS OF THE TWO COAL-FIRED BOILERS. *4TH QTR 78: THE 317L SS SIEVE TRAYS ARE WORKING WELL. FUEL USED, WAS A MIXTURE OF 0.5% SULFUR COAL AND 3.5% SULFUR COKE. BOTH SCRUBBERS DEMONSTRATED 100% RELIABILITY DURING THIS PERIOD.
MEAD PAPERBOARD CO. STEVENSON, ALABAMA AIRPOL INDUSTRIES OIL (1.5% - 3% SULFUR) 100,000 SCFM (TOTAL - 2 BOILERS) START-UP 0/75 SODIUM CARBONATE SCRUBBING STATUS - OPERATIONAL	*BKGD: AIRPOL INDUSTRIES HAS SUPPLIED A PARTICULATE AND SO2 CONTROL SYSTEM FOR THE TWO OIL-FIRED BOILERS AT THIS MEAD PULP MILL. *4TH QTR 78: THE SCRUBBER DEMONSTRATED 100% RELIABILITY DURING THE REPORT PERIOD. IN NOVEMBER ONE BOILER WAS DOWN FOR 24 HOURS AND THE OTHER FOR 48 HOURS TO REPLACE SEALS AND PREHEATERS. THE BOILERS OPERATED AT APPROXIMATELY 80% LOAD.
MINN-DAK FARMER'S CO-OPERATIVE WAHPETON, NORTH DAKOTA KOCH ENGINFERING LIGNITE (1.0% SULFUR) 164,000 SCFM (TOTAL - 2 BOILERS) START-UP 6/77 AMMONIA SCRUBBING STATUS - OPERATIONAL	*BKGD: KOCH ENGINEERING HAS SUPPLIED TWO AMMONIA-BASED SO2 CONTROL SYSTEMS FOR THESE COAL-FIRED BOILERS. EACH YEAR THE PLANT ONLY PRODUCES SUGAR DURING THE SEPTEMBER-FEBRUARY PERIOD. *4TH QTR 78: PLANS ARE BEING MADE TO ENCLOSE MORE OF THE WASTE TREATMENT FACILITIES SINCE EXCESSIVE HEAT LOSS IN THE DIGESTERS WAS A CONCERN. THE FGD SYSTEM OPERATED PROBLEM FREE DURING THE REPORT PERIOD.
MOBIL OIL COMPANY BUTTONWILLOW, CALIFORNIA HEATER TECHNOLOGY OIL (1.1% SULFUR) 80,500 SCFM (TOTAL - 7 BOILERS) START-UP 2/79 SODIUM CARBONATE SCRUBBING STATUS - CONSTRUCTION	*BKGD: MOBIL OIL HAS PURCHASED SEVEN EDUCTOR-TYPE SCRUBBERS FROM HEATER TECHNOLOGY FOR THE CONTROL OF EMISSIONS FROM 7 STEAM GENERATORS (25 MM BTU/HR). EACH SYSTEM CONSISTS OF A VENTURI SECTION, A RECYCLE TANK, AND AN OUTLET DUCT WITH A MIST ELIMINATOR. *4TH QTR 78: START-UP DATE HAS BEEN EXTENDED TO FEBRUARY 1979 DUE TO DELAYS IN AWARDING SUBCONTRACTS FOR PIPING AND OTHER WORK.

SECTION 3 (CONTINUED)

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	BACKGROUND AND SUMMARY OF RECENT OPERATIONS
MOBIL OIL COMPANY SAN ARDO, CALIFORNIA IN-HOUSE DESIGN OIL (2.0% - 2.25% SULFUR) 175,000 SCFM (TOTAL - 28 BOILERS) START-UP 0/74 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	*BKDG: MOBIL HAS DESIGNED THE FGD SYSTEM BY IN-HOUSE ENGINEERING BASED ON A PATENTED SODIUM HYDROXIDE SCRUBBING PROCESS. THE I.D. FANS ARE LINED WITH EPOXY RESIN TO REDUCE CORROSION. *4TH QTR 78: BECKMAN PH CONTROLLERS ARE WORKING WELL AND ADDITIONAL UNITS HAVE BEEN INSTALLED. AN AVAILABILITY OF ABOUT 95% WAS DEMONSTRATED BY THE FGD SYSTEM DURING THE REPORT PERIOD.
NEKOOSA PAPERS, INC. ASHDOWN, ARKANSAS AIRPOL INDUSTRIES COAL (1% - 1.5% SULFUR) 211,000 SCFM (TOTAL - 1 BOILER) START-UP 2/76 CAUSTIC SCRUBBING STATUS - OPERATIONAL	*BKGD: THE FGD SYSTEM CONSISTS OF TWO AIRPOL CAUSTIC SCRUBBERS CONTROLLING FLYASH AND SULFUR DIOXIDE. *4TH QTR 78: NEKOOSA IS CURRENTLY USING PURCHASED CAUSTIC INSTEAD OF THEIR NORMAL ON-SITE CAUSTIC WASTE STREAM BECAUSE OF A PUMP FAILURE. ONE SCRUBBER MODULE WAS SHUTDOWN TO PATCH THE SEPARATOR LINING AND REPAIR CORROSION LEAKS. THE BOILER REMAINED OPERABLE BECAUSE THE ENTIRE GAS FLOW WAS HANDLED BY THE OTHER SCRUBBER.
NORTHERN OHIO SUGAR COMPANY FINDLAY, OHIO GREAT WESTERN SUGAR COAL (1.2% SULFUR, AVERAGE) 65,230 SCFM (TOTAL - 2 BOILERS) START-UP 10/74 SODIUM CARBONATE SCRUBBING STATUS - TERMINATED	*BKGD: THE VENTURI TOWER WAS MAINLY DESIGNED FOR PARTICULATE CONTROL, AND WAS STARTED UP IN OCTOBER '74. PARTICULATE AND SO2 REMOVAL EFFICIENCIES WERE 90% AND 76% RESPECTIVELY. THE SO2 CONTROL WAS EFFECTED BY THE PROCESS CONDENSATE USED FOR SCRUBBING (PH=8.7). *4TH QTR 78: THIS PLANT HAS TERMINATED ALL SUGAR PRODUCTION OPERATIONS. THE SCRUBBER OPERATED FROM OCTOBER 1974 THROUGH THE '77-'78 SEASON BEFORE THE SHUTDOWN OCCURRED.
NORTHERN OHIO SUGAR COMPANY FREEMONT, OHIO GREAT WESTERN SUGAR COAL (1% SULFUR) 40,000 SCFM (TOTAL - 2 BOILERS) START-UP 10/75 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	*BKGD: PARTICULATE AND SO2 EMISSIONS ARE BEING CONTROLLED BY A SCRUBBER/ABSORBER MODULE OF PROPRIETARY DESIGN. THE FLUE GAS IS GENERATED BY TWO UNION BOILERS, EACH RATED @ 70,000 LB/HR STEAM.
PHILLIP MORRIS, INC. CHESTERFIELD, VIRGINIA FLAKT, INC. COAL 39,000 SCFM (TOTAL - 1 BOILER) START-UP 6/79 SODIUM CARBONATE SCRUBBING STATUS - CONSTRUCTION	*4TH QTR 78: CONSTRUCTION IS NEARING COMPLETION ON A NON-REGENERABLE SODIUM CARBONATE FGD SYSTEM (SUPPLIED BY FLAKT, INC.) WHICH WILL CONTROL EMISSIONS FROM A NEW PULVERIZED COAL-FIRED BOILER GENERATING FLUE GAS EQUIVALENT TO 30 MW. THE FLAKT SYSTEM WILL REMOVE A MINIMUM OF 90% OF THE SO2 FROM 2/3 OF THE FLUE GAS; THE REMAINDER OF THE GAS WILL BE USED FOR REHEAT.
RICKENBACKER AIR FORCE BASE COLUMBUS, OHIO RESEARCH-COTTRELL/BAHCO COAL (3.6% SULFUR) 55,000 SCFM (TOTAL - 7 BOILERS) START-UP 3/76 LIMESTONE SCRUBBING STATUS - OPERATIONAL	*BKGD: THIS RESEARCH-COTTRELL/BACHO LIME FGD UNIT WAS FIRST PLACED IN SERVICE MARCH 11, 1976. THE SYSTEM WAS SWITCHED OVER TO LIMESTONE IN APRIL 1977, AND HAS REMAINED IN THAT OPERATING MODE TO DATE. *4TH QTR 78: A TOTAL OF 36 HOURS DOWNTIME WERE REPORTED FOR THIS PERIOD, YIELDING AN AVAILABILITY OF 98.4%. THE NUCLEAR DENSITY CONTROL VALVE ON THE THICKENER UNDERFLOW WAS REPAIRED AND CAUSED NO DOWNTIME.
SHELL OIL COMPANY BAKERSFIELD, CALIFORNIA VENDOR NOT YET SELECTED OIL (1.1% SULFUR) 99,000 SCFM (TOTAL - 8 BOILERS) START-UP 0/ 0 PROCESS NOT YET SELECTED STATUS - PLANNED-CONSIDERING SO2 CONTROL	*BKGD: SHELL OIL IS CONSIDERING IMPLEMENTING FGD TECHNOLOGY TO CONTROL EMISSIONS FROM 8 SMALL OIL-FIRED (1.1% SULFUR) STEAM GENERATORS. NO PROCESS OR START-UP DATE HAVE AS YET BEEN SPECIFIED. AN SO2 REMOVAL EFFICIENCY OF 94% WILL BE REQUIRED.

SECTION 3 (CONTINUED)

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	BACKGROUND AND SUMMARY OF RECENT OPERATIONS
SHELL OIL COMPANY TAFT, CALIFORNIA VENDOR NOT YET SELECTED OIL (1.1% SULFUR) 25,000 SCFM (TOTAL - 2 BOILERS) START-UP 0/ 0 PROCESS NOT YET SELECTED STATUS - PLANNED-CONSIDERING SO2 CONTROL	*BKGD: SHELL OIL IS CONSIDERING IMPLEMENTING FGD TECHNOLOGY TO CONTROL EMISSIONS FROM 2 SMALL OIL-FIRED (1.1% SULFUR) STEAM GENERATORS. NO PROCESS OR START-UP DATE HAVE AS YET BEEN SPECIFIED. AN SO2 REMOVAL EFFICIENCY OF 94% WILL BE REQUIRED.
SHELLER GLOBE CORP. NORFOLK, VIRGINIA W.W. SLY MANUFACTURING CO. COAL (< 1.0% SULFUR) 8,000 SCFM (TOTAL - 1 BOILER) START-UP 0/75 SODIUM HYDROXIDE SCRUBBING STATUS - INDEFINITELY SHUT DOWN	*BKGD: AFTER SYSTEM RESTART IN OCTOBER 1977, THERE HAVE BEEN NO PROBLEMS RESULTING FROM EITHER BOILER OR SCRUBBER OPERATIONS. THE PLANT UNDERWENT A VIRGINIA EPA INSPECTION AND WAS FOUND TO BE IN COMPLIANCE WITH THE PARTICULATE EMISSION REGULATIONS. *4TH QTR 78: NO SCRUBBER RELATED PROBLEMS HAVE OCCURRED DURING THIS REPORT PERIOD. AT PRESENT THE USE OF NAOH HAS BEEN DISCONTINUED, SO THIS SYSTEM HAS BEEN MOVED TO OUR "INDEFINITELY SHUTDOWN" STATUS.
ST. JOE ZINC CO. MONACA, PENNSYLVANIA BUREAU OF MINES COAL (2.5% - 4.5% SULFUR) 142,000 SCFM (TOTAL - 1 BOILER) START-UP 3/79 CITRATE PROCESS STATUS - CONSTRUCTION	*BKGD: CONSTRUCTION CONTINUES ON THE CITRATE PROCESS SCRUBBING SYSTEM WHICH WILL CONTROL SO2 EMISSIONS FROM A 60-MW (NOMINAL PEAK CAPACITY) COAL-FIRED POWER GENERATING UNIT. STARTUP IS SCHEDULED FOR MARCH 1979. THIS SYSTEM WILL ALSO BE REPORTED IN THE EPA/PEDCO UTILITY FGD SURVEY, SINCE THE SYSTEM WILL BE OPERATED WITH A UTILITY-TYPE LOAD PROFILE, DURING THE ONE-YEAR DEMONSTRATION PERIOD.
ST. REGIS PAPER CO. CANTONMENT, FLORIDA AIRPOL INDUSTRIES BARK,OIL/GAS (< 1.0% SULFUR) 115,000 SCFM (1 BOILER) START-UP 0/73 CAUSTIC SCRUBBING STATUS - OPERATIONAL	*BKGD: AIRPOL HAS SUPPLIED THE CAUSTIC SCRUBBING SYSTEM TO REMOVE PARTICULATE AND SULFUR DIOXIDE FROM THE FLUE GAS OF A BARK BOILER, WHICH CAN ALSO FIRE NATURAL GAS AND OIL. *4TH QTR 78: PLANT HAS CHANGED THE FEEDWATER SOURCE FROM SCREEN ROOM BLACK WATER TO EVAPORATOR CONDENSATE WATER, TO ALLEVIATE PLUGGING PROBLEMS IN THE MIST ELIMINATOR AND PIPING.
SUN PRODUCTION COMPANY FELLOWS, CALIFORNIA C-E NATCO OIL (1.4% SULFUR) 6,000 SCFM (12,000 ACFM @ 570 F) START-UP 4/79 SODIUM HYDROXIDE SCRUBBING STATUS - CONSTRUCTION	*BKGD: SUN OIL HAS FOUR 25 MM BTU/HR AND TWO 50 MM BTU/HR STEAM GENERATORS AT THIS OIL SITE. THE CRUDE OIL HAS 1.4 PERCENT SULFUR. *4TH QTR 78: C-E NATCO IS CONSTRUCTING THE SYSTEM. STARTUP DATE IS APRIL 1979.
SUN PRODUCTION COMPANY OILDALE, CALIFORNIA C-E NATCO OIL (1.2% SULFUR) 6,000 SCFM (12,000 ACFM @ 570 F) START-UP 4/79 SODIUM HYDROXIDE SCRUBBING STATUS - CONSTRUCTION	*BKGD: SUN OIL HAS TWO 25 MM BTU/HR STEAM GENERATORS AT THIS OIL SITE. THE CRUDE OIL HAS 1.2 PERCENT SULFUR. *4TH QTR 78: THE SYSTEM, SUPPLIED BY C-E NATCO, IS UNDER CONSTRUCTION. STARTUP IS EXPECTED TO OCCUR BY APRIL 1979.
TENNECO OIL CO. GREEN RIVER, WYOMING VENDOR NOT YET SELECTED COAL (1.5% SULFUR, MAXIMUM) 140,000 SCFM (TOTAL - 2 BOILERS) START-UP 1/82 SODIUM CARBONATE SCRUBBING STATUS - PLANNED-REQUESTING/EVALUATING BIDS	*BKGD: TENNECO OIL HAS RETAINED BROWN AND ROOT FOR THE DESIGN OF A SODA ASH PLANT AND THE CONCOMMITTANT POLLUTION CONTROL EQUIPMENT. THE PLANT WILL BE LOCATED IN GREEN RIVER, WYOMING AND WILL HAVE TWO BOILERS BURNING WYOMING COAL. *4TH QTR 78: TENNECO AND B&R ARE EVALUATING BIDS FOR THE SODIUM CARBONATE SCRUBBING SYSTEMS WHICH WILL CONTROL SO2 EMISSIONS FROM THE BOILERS.

SECTION 3 (CONTINUED)

SUMMARY OF FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY INFORMATION	BACKGROUND AND SUMMARY OF RECENT OPERATIONS
TEXACO INCORPORATED SAN ARDO, CALIFORNIA CEILCOTE OIL (1.7% SULFUR) 380,000 SCFM (TOTAL - 32 BOILERS) START-UP 11/73 SODIUM HYDROXIDE SCRUBBING STATUS - OPERATIONAL	*BKGD: FGD SYSTEM CONSISTS OF A HORIZONTAL, PACKED-BED SCRUBBER FOR EACH OF THE OIL-FIRED BOILERS. *4TH QTR 78: CORROSION IN THE QUENCHER AND ABRASION/PLUGGING IN THE ABSORBER CONTINUE TO BE PROBLEM AREAS. DURING THIS QUARTER EACH SCRUBBER WAS SHUTDOWN FOR MAINTENANCE AN AVERAGE OF 100 HOURS. TEXACO IS PLANNING TO PHASE OUT THIS GROUP OF SCRUBBERS BY LATE 1979.
TEXACO INCORPORATED SAN ARDO, CALIFORNIA DUCON COMPANY OIL (1.7% SULFUR) 117,000 SCFM (TOTAL - 9 BOILERS) START-UP 3/79 SODIUM CARBONATE SCRUBBING STATUS - CONSTRUCTION	*BKGD: TEXACO IS PLANNING TO PHASE OUT THE EXISTING FGD SYSTEMS AT THEIR SAN ARDO, CALIFORNIA SITE. AS THE FIRST STEP OF THE PROGRAM, 9 OF THE PRESENT 31 SCRUBBERS ON 50 MM BTU/HR STEAM GENERATORS ARE BEING REPLACED BY A NEW SYSTEM, SUPPLIED BY DUCON COMPANY. THE NEW FGD SYSTEM WILL CONSIST OF THREE TRAINS OF A VENTURI SCRUBBER/SPRAY ABSORBER COMBINATION. *4TH QTR 78: THE THREE FGD SYSTEMS HAVE BEEN DELIVERED AND CONSTRUCTION IS PROGRESSING AS SCHEDULED.
TEXASGULF GRANGER, WYOMING SWEMCO INC. COAL (0.75% SULFUR) 140,000 SCFM (TOTAL - 2 BOILERS) START-UP 9/76 SODIUM CARBONATE SCRUBBING STATUS - OPERATIONAL	*BKGD: THIS SODIUM CARBONATE SCRUBBING SYSTEM WAS DESIGNED BY SWEMCO. SO2 ABSORPTION OCCURS IN THE QUENCHER AND THE SIEVE-TRAY ABSORBER MODULE. AN INTERESTING FEATURE IS AN INTERNAL DAMPER WHICH ALLOWS A 4 TO 1 TURNDOWN RATIO. *4TH QTR 78: DURING A SCHEDULED INSPECTION ON NO. 2 BOILER IN THIS PERIOD, THE INTERIOR OF THE QUENCHER/SCRUBBER WAS CLEANED. THE SCRUBBER OPERATED WITH 100% RELIABILITY, DURING THE PERIOD.
TRANSCO TEXTILES, INC. AUGUSTA, GEORGIA FMC ENVIRONMENTAL EQUIPMENT FUEL OIL (2% MAX. SULFUR) 50,000 ACFM START-UP 3/75 SODIUM CARBONATE SCRUBBING STATUS - INDEFINITELY SHUT DOWN	*BKGD: THE FGD OPERATIONS HAVE BEEN TERMINATED FOR AN INDEFINITE PERIOD. THE PLANT BURNS NUMBER 6 FUEL OIL AND THE SULFUR DIOXIDE EMISSIONS ARE 50% OF THE EXISTING REGULATIONS. THE BOILER IS RATED AT 20 MW (EQUIVALENT) AND PRODUCES 150,000 LBS/HR STEAM. WHEN OPERATIONAL, THE SCRUBBER SYSTEM HAD A FLUE GAS VOLUME OF 50,000 ACFM AT 140 DEGREES F. SYSTEM START-UP OCCURRED IN MARCH 1975 AND SCRUBBER OPERATIONS WERE TERMINATED LATER IN THE SAME YEAR. THERE ARE CURRENTLY NO PLANS TO INITIATE OPERATIONS.
U.S. GYPSUM CORP. OAKMONT, PENNSYLVANIA AIRPOL INDUSTRIES COAL 19,300 SCFM (TOTAL - 4 BOILERS) START-UP 0/ 0 DOUBLE ALKALI (DILUTE) STATUS - NEVER STARTED-UP	*BKGD: AN AIRPOL DOUBLE ALKALI SCRUBBING SYSTEM IS ON-SITE, INSTALLED, AND READY FOR OPERATIONS. HOWEVER, US GYPSUM DECIDED NOT TO INITIATE PRODUCTION AT THIS FACILITY FOR ECONOMIC REASONS. *4TH QTR 78: A CHECK DURING THIS PERIOD REVEALED THAT THE PLANT HAS NOT BEEN STARTED YET.
WESTERN CORRECTIONAL INST. PITTSBURG, PENNSYLVANIA PITTSBURG ENV. & ENGY. SYSTEMS COAL (3.5% SULFUR) 10,000 SCFM (TOTAL - 1 BOILER) START-UP 11/79 SULF-X SCORE STATUS - PLANNED-CONTRACT AWARDED	*BKGD: A NEW FGD PROCESS KNOWN AS THE SULF-X PROCESS HAS BEEN DEVELOPED BY PITTSBURG ENVIORNMENTAL AND ENERGY SYSTEMS, INC. AND WILL CONTROL SO2 EMISSIONS FROM AN EXISTING BOILER AT THE WESTERN CORRECTIONAL INSTITUTE IN PITTSBURG. FUNDING IS BEING PROVIDED BY THE COMMONWEALTH OF PENNSYLVANIA. MINE ACID WASTES WILL BE USED AS THE REAGENT TO REMOVE SO2 AND NOX FROM THE FLUE GASES.

SECTION 4

SUMMARY BY VENDOR OF FGD SYSTEMS ON INDUSTRIAL BOILERS

VENDOR	INSTALLATION NAME / LOCATION	CONTROL SYSTEM PROCESS
A.D. LITTLE	GENERAL MOTORS CORPORATION ST. LOUIS, MISSOURI	SODIUM HYDROXIDE SCRUBBING
AIRPOL INDUSTRIES	GEORGIA-PACIFIC PAPER CO. CROSSETT, ARKANSAS	CAUSTIC WASTE STREAM
	GREAT SOUTHERN PAPER CO. CEDAR SPRINGS, GEORGIA	CAUSTIC WASTE STREAM
	GRISSOM AIR FORCE BASE BUNKER HILL, INDIANA	DOUBLE ALKALI (CONCENTRATED)
	ITT RAYONIER, INC. FERNANDINA BEACH, FLORIDA	SODIUM HYDROXIDE SCRUBBING
	MEAD PAPERBOARD CO. STEVENSON, ALABAMA	SODIUM CARBONATE SCRUBBING
	NEKOOSA PAPERS, INC. ASHDOWN, ARKANSAS	CAUSTIC SCRUBBING
	ST. REGIS PAPER CO. CANTONMENT, FLORIDA	CAUSTIC SCRUBBING
	U.S. GYPSUM CORP. OAKMONT, PENNSYLVANIA	DOUBLE ALKALI (DILUTE)
BUREAU OF MINES	ST. JOE ZINC CO. MONACA, PENNSYLVANIA	CITRATE PROCESS
C-E NATCO	BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA	SODIUM HYDROXIDE SCRUBBING
	SUN PRODUCTION COMPANY FELLOWS, CALIFORNIA	SODIUM HYDROXIDE SCRUBBING
	SUN PRODUCTION COMPANY OILDALE, CALIFORNIA	SODIUM HYDROXIDE SCRUBBING
CARBORUNDUM ENVIR. SYS. LTD.	CARBORUNDUM ABRASIVES BUFFALO, NEW YORK	LIME SCRUBBING
CEILCOTE	TEXACO INCORPORATED SAN ARDO, CALIFORNIA	SODIUM HYDROXIDE SCRUBBING
COMBUSTION EQUIPMENT ASSOC.	KERR-MCGEE CHEMICAL CORP. TRONA, CALIFORNIA	SODIUM CARBONATE SCRUBBING
DRAVO CORP./NAT'L LIME ASS'N	BUNGE, INC. CAIRO, ILLINOIS	LIME SCRUBBING
DUCON COMPANY	TEXACO INCORPORATED SAN ARDO, CALIFORNIA	SODIUM CARBONATE SCRUBBING
ENTOLETER, INC.	GENERAL MOTORS CORPORATION DAYTON, OHIO	SODIUM HYDROXIDE SCRUBBING
FLAKT, INC.	PHILLIP MORRIS, INC. CHESTERFIELD, VIRGINIA	SODIUM CARBONATE SCRUBBING
FMC ENVIRONMENTAL EQUIPMENT	ALYESKA PIPELINE SERVICE CO. VALDEZ, ALASKA	SODIUM HYDROXIDE SCRUBBING
	ARCO/POLYMERS, INC. MONACA, PENNSYLVANIA	DOUBLE ALKALI (CONCENTRATED)
	CANTON TEXTILES CANTON, GEORGIA	CAUSTIC WASTE STREAM

SECTION 4 (CONTINUED)

SUMMARY BY VENDOR OF FGD SYSTEMS ON INDUSTRIAL BOILERS

VENDOR	INSTALLATION NAME / LOCATION	CONTROL SYSTEM PROCESS
FMC ENVIRONMENTAL EQUIPMENT	CATERPILLAR TRACTOR CO. EAST PEORIA, ILLINOIS	DOUBLE ALKALI (CONCENTRATED)
	CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS	DOUBLE ALKALI (CONCENTRATED)
	CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS	DOUBLE ALKALI (CONCENTRATED)
	CATERPILLAR TRACTOR CO. MOSSVILLE, ILLINOIS	DOUBLE ALKALI (CONCENTRATED)
	CHANSLOR WESTERN OIL & DEV. CO BAKERSFIELD, CALIFORNIA	DOUBLE ALKALI (CONCENTRATED)
	FIRESTONE TIRE AND RUBBER CO. POTTSTOWN, PENNSYLVANIA	DOUBLE ALKALI (CONCENTRATED)
	FMC (SODA ASH PLANT) GREEN RIVER, WYOMING	SODIUM CARBONATE SCRUBBING
	GENERAL MOTORS CORPORATION TONOWANDA, NEW YORK	SODIUM HYDROXIDE SCRUBBING
	GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA	SODIUM CARBONATE SCRUBBING
	TRANSCO TEXTILES, INC. AUGUSTA, GEORGIA	SODIUM CARBONATE SCRUBBING
GM ENVIRONMENTAL	GENERAL MOTORS CORPORATION PARMA, OHIO	DOUBLE ALKALI (DILUTE)
	GENERAL MOTORS CORPORATION PONTIAC, MICHIGAN	SODIUM HYDROXIDE SCRUBBING
GREAT WESTERN SUGAR	GREAT WESTERN SUGAR BILLINGS, MONTANA	AMMONIA-LADEN PROCESS WATER
	GREAT WESTERN SUGAR FORT MORGAN, COLORADO	AMMONIA-LADEN PROCESS WATER
	GREAT WESTERN SUGAR GERING, NEBRASKA	AMMONIA-LADEN PROCESS WATER
	GREAT WESTERN SUGAR GREELEY, COLORADO	AMMONIA-LADEN PROCESS WATER
	GREAT WESTERN SUGAR LONGMONT, COLORADO	AMMONIA-LADEN PROCESS WATER
	GREAT WESTERN SUGAR LOVELAND, COLORADO	AMMONIA-LADEN PROCESS WATER
	GREAT WESTERN SUGAR SCOTTS BLUFF, NEBRASKA	AMMONIA-LADEN PROCESS WATER
	NORTHERN OHIO SUGAR COMPANY FINDLAY, OHIO	SODIUM CARBONATE SCRUBBING
	NORTHERN OHIO SUGAR COMPANY FREEMONT, OHIO	SODIUM HYDROXIDE SCRUBBING
HEATER TECHNOLOGY	BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA	SODIUM HYDROXIDE SCRUBBING
	MOBIL OIL COMPANY BUTTONWILLOW, CALIFORNIA	SODIUM CARBONATE SCRUBBING

SECTION 4 (CONTINUED)

SUMMARY BY VENDOR OF FGD SYSTEMS ON INDUSTRIAL BOILERS

VENDOR	INSTALLATION NAME / LOCATION	CONTROL SYSTEM PROCESS
IN-HOUSE DESIGN	GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA	SODIUM CARBONATE SCRUBBING
	GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA	SODIUM CARBONATE SCRUBBING
	MOBIL OIL COMPANY SAN ARDO, CALIFORNIA	SODIUM HYDROXIDE SCRUBBING
KOCH ENGINEERING	ARMCO STEEL MIDDLETOWN, OHIO	LIME SCRUBBING
	CHEVRON U.S.A. INC. BAKERSFIELD, CALIFORNIA	SODIUM CARBONATE SCRUBBING
	CHEVRON U.S.A. INC. BAKERSFIELD, CALIFORNIA	SODIUM CARBONATE SCRUBBING
	MINN-DAK FARMER'S CO-OPERATIVE WAHPETON, NORTH DAKOTA	AMMONIA SCRUBBING
PITTSBURG ENV. & ENGY. SYSTEMS	WESTERN CORRECTIONAL INST. PITTSBURG, PENNSYLVANIA	SULF-X SCORE
RESEARCH-COTTRELL/BAHCO	RICKENBACKER AIR FORCE BASE COLUMBUS, OHIO	LIMESTONE SCRUBBING
SWEMCO INC.	TEXASGULF GRANGER, WYOMING	SODIUM CARBONATE SCRUBBING
THERMOTICS INC.	BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA	SODIUM HYDROXIDE SCRUBBING
VENDOR NOT YET SELECTED	C.A.M.(CARBIDE-AMOCO-MONSANTO) HOUSTON, TEXAS	PROCESS NOT YET SELECTED
	DUPONT, INC. GEORGIA	DOUBLE ALKALI
	DUPONT, INC. TEXAS	LIMESTONE SCRUBBING
	SHELL OIL COMPANY BAKERSFIELD, CALIFORNIA	PROCESS NOT YET SELECTED
	SHELL OIL COMPANY TAFT, CALIFORNIA	PROCESS NOT YET SELECTED
	TENNECO OIL CO. GREEN RIVER, WYOMING	SODIUM CARBONATE SCRUBBING
W.W. SLY MANUFACTURING CO.	AMERICAN THREAD CO. MARION, NORTH CAROLINA	CAUSTIC WASTE STREAM
	HARRIS MINING CO. SPRUCE PINE, NORTH CAROLINA	WATER SCRUBBING (NA,NH3 OPTN.)
	SHELLER GLOBE CORP. NORFOLK, VIRGINIA	SODIUM HYDROXIDE SCRUBBING
ZURN INDUSTRIES	CATERPILLAR TRACTOR CO. JOLIET, ILLINOIS	DOUBLE ALKALI (DILUTE)
	CATERPILLAR TRACTOR CO. MORTON, ILLINOIS	DOUBLE ALKALI (DILUTE)

SECTION 5

OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY/LOCATION/FUEL	NEW/ RETROFIT	UNIT SIZE (SCFM)	PROCESS/VENDOR	START-UP MO/YR
ALYESKA PIPELINE SERVICE CO. VALDEZ, ALASKA OIL (0.03% - 0.1% SULFUR)	NEW	50,000	SODIUM HYDROXIDE SCRUBBING FMC ENVIRONMENTAL EQUIPMENT	6/77
AMERICAN THREAD CO. MARION, NORTH CAROLINA COAL (1 - 1.5% SULFUR)	RETROFIT	18,500	CAUSTIC WASTE STREAM W.W. SLY MANUFACTURING CO.	0/73
ARMCO STEEL MIDDLETOWN, OHIO COAL (0.8% SULFUR)	RETROFIT	84,000	LIME SCRUBBING KOCH ENGINEERING	0/75
BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA OIL (1.1% SULFUR)	NEW	12,000	SODIUM HYDROXIDE SCRUBBING HEATER TECHNOLOGY	6/78
BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA CRUDE OIL (1.1% SULFUR)	NEW	12,000	SODIUM HYDROXIDE SCRUBBING THERMOTICS INC.	7/78
CANTON TEXTILES CANTON, GEORGIA COAL (0.8% SULFUR) INTERRUPTIBLE NATURAL GAS	RETROFIT	25,000	CAUSTIC WASTE STREAM FMC ENVIRONMENTAL EQUIPMENT	6/74
CATERPILLAR TRACTOR CO. EAST PEORIA, ILLINOIS COAL (3.2% SULFUR)	2 NEW, 2 RETRO	210,000	DOUBLE ALKALI (CONCENTRATED) FMC ENVIRONMENTAL EQUIPMENT	4/78
CATERPILLAR TRACTOR CO. MOSSVILLE, ILLINOIS COAL (3.2% SULFUR)	2 NEW 2 RETRO	140,000	DOUBLE ALKALI (CONCENTRATED) FMC ENVIRONMENTAL EQUIPMENT	10/75
CATERPILLAR TRACTOR CO. JOLIET, ILLINOIS COAL (3.2% SULFUR)	RETROFIT	67,000	DOUBLE ALKALI (DILUTE) ZURN INDUSTRIES	9/74
CATERPILLAR TRACTOR CO. MORTON, ILLINOIS COAL (3.2% SULFUR)	RETROFIT	38,000	DOUBLE ALKALI (DILUTE) ZURN INDUSTRIES	1/78
CHEVRON U.S.A. INC. BAKERSFIELD, CALIFORNIA OIL (1.1% SULFUR)	RETROFIT	248,000	SODIUM CARBONATE SCRUBBING KOCH ENGINEERING	7/78
FIRESTONE TIRE AND RUBBER CO. POTTSTOWN, PENNSYLVANIA COAL (2.5 - 3.0% SULFUR)	RETROFIT	8070	DOUBLE ALKALI (CONCENTRATED) FMC ENVIRONMENTAL EQUIPMENT	1/75
FMC (SODA ASH PLANT) GREEN RIVER, WYOMING COAL (1% SULFUR)	NEW	446,000	SODIUM CARBONATE SCRUBBING FMC ENVIRONMENTAL EQUIPMENT	5/76

SECTION 5 (CONTINUED)

OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY/LOCATION/FUEL	NEW/ RETROFIT	UNIT SIZE (SCFM)	PROCESS/VENDOR	START-UP MO/YR
GENERAL MOTORS CORPORATION ST. LOUIS, MISSOURI COAL (3.2% SULFUR)	RETROFIT	64,000	SODIUM HYDROXIDE SCRUBBING A.D. LITTLE	0/72
GENERAL MOTORS CORPORATION DAYTON, OHIO COAL(0.7% - 2.0% SULFUR)	RETROFIT	36,000	SODIUM HYDROXIDE SCRUBBING ENTOLETER, INC.	9/74
GENERAL MOTORS CORPORATION TONOWANDA, NEW YORK COAL (1.2% SULFUR)	RETROFIT	92,000	SODIUM HYDROXIDE SCRUBBING FMC ENVIRONMENTAL EQUIPMENT	6/75
GENERAL MOTORS CORPORATION PARMA, OHIO COAL (2.5% SULFUR)	RETROFIT	128,400	DOUBLE ALKALI (DILUTE) GM ENVIRONMENTAL	3/74
GENERAL MOTORS CORPORATION PONTIAC, MICHIGAN COAL (0.84% SULFUR) ALSO WOOD, PAPER, AND CARDBOARD.	NEW	107,300	SODIUM HYDROXIDE SCRUBBING GM ENVIRONMENTAL	4/76
GEORGIA-PACIFIC PAPER CO. CROSSETT, ARKANSAS BARK,COAL/OIL (1.5% - 2.0% SULFUR)	NEW	220,000	CAUSTIC WASTE STREAM AIRPOL INDUSTRIES	7/75
GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA OIL (1.1% SULFUR)	RETROFIT	72,000	SODIUM CARBONATE SCRUBBING FMC ENVIRONMENTAL EQUIPMENT	6/77
GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA OIL (1.1% SULFUR)	RETROFIT	495,000	SODIUM CARBONATE SCRUBBING IN-HOUSE DESIGN	12/78
GREAT SOUTHERN PAPER CO. CEDAR SPRINGS, GEORGIA BARK,COAL/OIL (1.0% - 2.0% SULFUR)	RETROFIT	420,000	CAUSTIC WASTE STREAM AIRPOL INDUSTRIES	0/75
GREAT WESTERN SUGAR BILLINGS, MONTANA COAL (0.7% SULFUR)	RETROFIT	60,000	AMMONIA-LADEN PROCESS WATER GREAT WESTERN SUGAR	10/77
GREAT WESTERN SUGAR FORT MORGAN, COLORADO COAL (1.2% SULFUR, AVERAGE)	RETROFIT	65,230	AMMONIA-LADEN PROCESS WATER GREAT WESTERN SUGAR	10/76
GREAT WESTERN SUGAR GERING, NEBRASKA COAL (1.2% SULFUR, AVERAGE)	RETROFIT	110,000	AMMONIA-LADEN PROCESS WATER GREAT WESTERN SUGAR	10/75
GREAT WESTERN SUGAR GREELEY, COLORADO COAL (0.6% SULFUR)	RETROFIT	25,000	AMMONIA-LADEN PROCESS WATER GREAT WESTERN SUGAR	10/75

SECTION 5 (CONTINUED)

OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY/LOCATION/FUEL	NEW/ RETROFIT	UNIT SIZE (SCFM)	PROCESS/VENDOR	START-UP MO/YR
GREAT WESTERN SUGAR LOVELAND, COLORADO COAL (1.2% SULFUR, AVERAGE)	RETROFIT	121,800	AMMONIA-LADEN PROCESS WATER GREAT WESTERN SUGAR	10/73
GREAT WESTERN SUGAR SCOTTS BLUFF, NEBRASKA COAL (1.2% SULFUR, AVERAGE)	RETROFIT	65,230	AMMONIA-LADEN PROCESS WATER GREAT WESTERN SUGAR	10/75
ITT RAYONIER, INC. FERNANDINA BEACH, FLORIDA BARK,OIL (2.0% - 2.5% SULFUR)	RETROFIT	176,000	SODIUM HYDROXIDE SCRUBBING AIRPOL INDUSTRIES	0/75
KERR-MCGEE CHEMICAL CORP. TRONA, CALIFORNIA COKE/COAL/OIL (0.5% - 5.0% SULFUR)	NEW	490,000	SODIUM CARBONATE SCRUBBING COMBUSTION EQUIPMENT ASSOC.	6/78
MEAD PAPERBOARD CO. STEVENSON, ALABAMA OIL (1.5% - 3% SULFUR)	NEW	100,000	SODIUM CARBONATE SCRUBBING AIRPOL INDUSTRIES	0/75
MINN-DAK FARMER'S CO-OPERATIVE WAHPETON, NORTH DAKOTA LIGNITE (1.0% SULFUR)	RETROFIT	164,000	AMMONIA SCRUBBING KOCH ENGINEERING	6/77
MOBIL OIL COMPANY SAN ARDO, CALIFORNIA OIL (2.0% - 2.25% SULFUR)	RETROFIT	175,000	SODIUM HYDROXIDE SCRUBBING IN-HOUSE DESIGN	0/74
NEKOOSA PAPERS, INC. ASHDOWN, ARKANSAS COAL (1% - 1.5% SULFUR)	NEW	211,000	CAUSTIC SCRUBBING AIRPOL INDUSTRIES	2/76
NORTHERN OHIO SUGAR COMPANY FREEMONT, OHIO COAL (1% SULFUR)	RETROFIT	40,000	SODIUM HYDROXIDE SCRUBBING GREAT WESTERN SUGAR	10/75
RICKENBACKER AIR FORCE BASE COLUMBUS, OHIO COAL (3.6% SULFUR)	RETROFIT	55,000	LIMESTONE SCRUBBING RESEARCH-COTTRELL/BAHCO	3/76
ST. REGIS PAPER CO. CANTONMENT, FLORIDA BARK,OIL/GAS (< 1.0% SULFUR)	RETROFIT	115,000	CAUSTIC SCRUBBING AIRPOL INDUSTRIES	0/73
TEXACO INCORPORATED SAN ARDO, CALIFORNIA OIL (1.7% SULFUR)	RETROFIT	380,000	SODIUM HYDROXIDE SCRUBBING CEILCOTE	11/73
TEXASGULF GRANGER, WYOMING COAL (0.75% SULFUR)	NEW	140,000	SODIUM CARBONATE SCRUBBING SWEMCO INC.	9/76

SECTION 6

UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY/LOCATION/FUEL	NEW/ RETROFIT	UNIT SIZE (SCFM)	PROCESS/VENDOR	START-UP MO/YR
ARCO/POLYMERS, INC. MONACA, PENNSYLVANIA COAL (3.0% SULFUR)	RETROFIT	236,000	DOUBLE ALKALI (CONCENTRATED) FMC ENVIRONMENTAL EQUIPMENT	6/80
BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA CRUDE OIL (1.1% SULFUR)	RETROFIT	12,000	SODIUM HYDROXIDE SCRUBBING C-E NATCO	1/79
CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS COAL (3.2% SULFUR)	NEW	131,000	DOUBLE ALKALI (CONCENTRATED) FMC ENVIRONMENTAL EQUIPMENT	1/79
CHANSLOR WESTERN OIL & DEV. CO BAKERSFIELD, CALIFORNIA OIL (1.5% SULFUR)	NEW	70,000	DOUBLE ALKALI (CONCENTRATED) FMC ENVIRONMENTAL EQUIPMENT	3/79
GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA OIL (1.1% SULFUR)	RETROFIT	396,000	SODIUM CARBONATE SCRUBBING IN-HOUSE DESIGN	1/79
MOBIL OIL COMPANY BUTTONWILLOW, CALIFORNIA OIL (1.1% SULFUR)	RETROFIT	80,500	SODIUM CARBONATE SCRUBBING HEATER TECHNOLOGY	2/79
PHILLIP MORRIS, INC. CHESTERFIELD, VIRGINIA COAL	NEW	39,000	SODIUM CARBONATE SCRUBBING FLAKT, INC.	6/79
ST. JOE ZINC CO. MONACA, PENNSYLVANIA COAL (2.5% - 4.5% SULFUR)	RETROFIT	142,000	CITRATE PROCESS BUREAU OF MINES	3/79
SUN PRODUCTION COMPANY FELLOWS, CALIFORNIA OIL (1.4% SULFUR)	RETROFIT	6,000	SODIUM HYDROXIDE SCRUBBING C-E NATCO	4/79
SUN PRODUCTION COMPANY OILDALE, CALIFORNIA OIL (1.2% SULFUR)	RETROFIT	6,000	SODIUM HYDROXIDE SCRUBBING C-E NATCO	4/79
TEXACO INCORPORATED SAN ARDO, CALIFORNIA OIL (1.7% SULFUR)	RETROFIT	117,000	SODIUM CARBONATE SCRUBBING DUCON COMPANY	3/79

SECTION 7

PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

COMPANY/LOCATION/FUEL	NEW/ RETROFIT	UNIT SIZE (SCFM)	PROCESS/VENDOR	START-UP MO/YR
CARBORUNDUM ABRASIVES BUFFALO, NEW YORK COAL (2.2% SULFUR)	RETROFIT	30,000	LIME SCRUBBING CARBORUNDUM ENVIR. SYS. LTD.	0/80
CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS COAL (3.2% SULFUR)	NEW	105,000	DOUBLE ALKALI (CONCENTRATED) FMC ENVIRONMENTAL EQUIPMENT	1/80
GRISSOM AIR FORCE BASE BUNKER HILL, INDIANA COAL (0.9% - 4.6% SULFUR)	1 NEW 2 RETRO	32,000	DOUBLE ALKALI (CONCENTRATED) AIRPOL INDUSTRIES	9/79
WESTERN CORRECTIONAL INST. PITTSBURG, PENNSYLVANIA COAL (3.5% SULFUR)	RETROFIT	10,000	SULF-X SCORE PITTSBURG ENV. & ENGY. SYSTEMS	11/79
CHEVRON U.S.A. INC. BAKERSFIELD, CALIFORNIA OIL (1.1% SULFUR)	RETROFIT	146,000	SODIUM CARBONATE SCRUBBING KOCH ENGINEERING	4/79
TENNECO OIL CO. GREEN RIVER, WYOMING COAL (1.5% SULFUR, MAXIMUM)	NEW	140,000	SODIUM CARBONATE SCRUBBING VENDOR NOT YET SELECTED	1/82
C.A.M.(CARBIDE-AMOCO-MONSANTO) HOUSTON, TEXAS FUEL NOT YET SELECTED	NEW	1,200,000	PROCESS NOT YET SELECTED VENDOR NOT YET SELECTED	0/84
DUPONT, INC. GEORGIA COAL (1.5% SULFUR)	NEW	280,000	DOUBLE ALKALI VENDOR NOT YET SELECTED	0/87
DUPONT, INC. TEXAS COAL (0.5% SULFUR)	NEW	320,000	LIMESTONE SCRUBBING VENDOR NOT YET SELECTED	0/82
SHELL OIL COMPANY BAKERSFIELD, CALIFORNIA OIL (1.1% SULFUR)	NEW	99,000	PROCESS NOT YET SELECTED VENDOR NOT YET SELECTED	0/ 0
SHELL OIL COMPANY TAFT, CALIFORNIA OIL (1.1% SULFUR)	NEW	25,000	PROCESS NOT YET SELECTED VENDOR NOT YET SELECTED	0/ 0

SECTION 8

SUMMARY OF DISPOSAL PRACTICES FOR FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME / LOCATION	STATUS/COMMENTS
ALKALINE SULFITE/BISULFITE RECYCLED TO PULP PROCESS	
MEAD PAPERBOARD CO. STEVENSON, ALABAMA	OPERATIONAL RECOVERED SOLUTION USED AS MAKE-UP TO COOKING LIQUOR IN PULP MILL.
NEKOOSA PAPERS, INC. ASHDOWN, ARKANSAS	OPERATIONAL SO2 RECOVERED FROM SODIUM SULFITE/SULFATE LIQUOR AND RECYCLED TO PULPING PROCESS.
DEWATERED SLURRY TO LANDFILL	
ARCO/POLYMERS, INC. MONACA, PENNSYLVANIA	CONSTRUCTION FLYASH ADDITION TO DEWATERED CASO3/CASO4 FILTER CAKE, THEN TO LANDFILL.
BUNGE, INC. CAIRO, ILLINOIS	INDEFINITELY SHUT DOWN
CATERPILLAR TRACTOR CO. EAST PEORIA, ILLINOIS	OPERATIONAL 60+% SOLIDS (CASO4) SLUDGE DIRECTLY TO LANDFILL
CATERPILLAR TRACTOR CO. MOSSVILLE, ILLINOIS	OPERATIONAL 60+% SOLIDS (CASO4) SLUDGE DIRECTLY TO LANDFILL
CATERPILLAR TRACTOR CO. JOLIET, ILLINOIS	OPERATIONAL
CATERPILLAR TRACTOR CO. MORTON, ILLINOIS	OPERATIONAL
CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS	CONSTRUCTION 60+% SOLIDS (CASO4) SLUDGE DIRECTLY TO LANDFILL
CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS	PLANNED-CONTRACT AWARDED 60+% SOLIDS (CASO4) SLUDGE DIRECTLY TO LANDFILL.
CHANSLOR WESTERN OIL & DEV. CO BAKERSFIELD, CALIFORNIA	CONSTRUCTION SALTS IS THEREBY PREVENTED.
DUPONT, INC. GEORGIA	PLANNED-CONSIDERING SO2 CONTROL
DUPONT, INC. TEXAS	PLANNED-CONSIDERING SO2 CONTROL
FIRESTONE TIRE AND RUBBER CO. POTTSTOWN, PENNSYLVANIA	OPERATIONAL
GENERAL MOTORS CORPORATION TONOWANDA, NEW YORK	OPERATIONAL FLY ASH AND NA2SO3/SO4 WASTE LIQUOR DEWATERED AND THEN TO SANITARY LANDFILL
GENERAL MOTORS CORPORATION PARMA, OHIO	OPERATIONAL 50+% SOLIDS (CASO3/SO4) SLUDGE TO DRYING POND AND LANDFILL
GENERAL MOTORS CORPORATION PONTIAC, MICHIGAN	OPERATIONAL 5% SOLIDS SLURRY DEWATERED AND TO LANDFILL
GRISSOM AIR FORCE BASE BUNKER HILL, INDIANA	PLANNED-CONTRACT AWARDED
U.S. GYPSUM CORP. OAKMONT, PENNSYLVANIA	NEVER STARTED-UP SLUDGE TO POND FOR DRYING. THEN TO LANDFILL.

SECTION 8 (CONTINUED)

SUMMARY OF DISPOSAL PRACTICES FOR FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME / LOCATION	STATUS/COMMENTS
HOLDING POND FOR EVAPORATION	
AMERICAN THREAD CO. MARION, NORTH CAROLINA	OPERATIONAL THE SODIUM SULFITE/SULFATE WASTE LIQUOR IS PUMPED TO A RED CLAY LINED ASH BASIN. LEACHING OF THE SOLUBLE SODIUM SALTS IS THEREBY PREVENTED.
ARMCO STEEL MIDDLETOWN, OHIO	OPERATIONAL
FMC (SODA ASH PLANT) GREEN RIVER, WYOMING	OPERATIONAL NA2SO3/SO4 LIQUOR DISPOSED TO COLLECTION POND - NO PRIOR AERATION. LANDFILL IN THE FUTURE
GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA	OPERATIONAL 6 GPM BLEEDOFF TO A BLOWDOWN TANK. THE BLOWDOWN IS THEN SENT TO A DISPOSAL POND ONCE A WEEK.
KERR-MCGEE CHEMICAL CORP. TRONA, CALIFORNIA	OPERATIONAL SCRUBBER EFFLUENT IS CLARIFIED AND THEN PUT INTO A MINERAL DEPOSIT.
MOBIL OIL COMPANY SAN ARDO, CALIFORNIA	OPERATIONAL
MOBIL OIL COMPANY BUTTONWILLOW, CALIFORNIA	CONSTRUCTION INTERMITTENT BLOWDOWN TO WASTE DISPOSAL SITE.
SUN PRODUCTION COMPANY FELLOWS, CALIFORNIA	CONSTRUCTION 1 GPM BLEEDOFF TO DISPOSAL POND
SUN PRODUCTION COMPANY OILDALE, CALIFORNIA	CONSTRUCTION 1 GPM BLEEDOFF TO DISPOSAL POND
TENNECO OIL CO. GREEN RIVER, WYOMING	PLANNED-REQUESTING/EVALUATING BIDS
NON-FIXATED SLURRY TO LINED POND	
CANTON TEXTILES CANTON, GEORGIA	OPERATIONAL NA SO3/SO4 LIQUOR DISPOSED TO LINED HOLDING PONDS
RICKENBACKER AIR FORCE BASE COLUMBUS, OHIO	OPERATIONAL UNSTABILIZED CASO3/SO4 SLUDGE TO LINED POND
REGENERABLE - ELEMENTAL SULFUR PRODUCT	
ST. JOE ZINC CO. MONACA, PENNSYLVANIA	CONSTRUCTION
WASTEWATER TREATMENT AND DISCHARGE TO CITY SEWER	
GENERAL MOTORS CORPORATION ST. LOUIS, MISSOURI	OPERATIONAL NA2SO3 OXIDIZED TO NA2SO4, PH NEUTRALIZED AND DISCHARGED TO CITY SEWER SYSTEM
GENERAL MOTORS CORPORATION DAYTON, OHIO	OPERATIONAL NA2SO3/SO4 LIQUOR AT 35 GPM TO ON-SITE CLARIFICATION AND DEWATERING FACILITY
GEORGIA-PACIFIC PAPER CO. CROSSETT, ARKANSAS	OPERATIONAL

SECTION 8 (CONTINUED)

SUMMARY OF DISPOSAL PRACTICES FOR FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME / LOCATION	STATUS/COMMENTS
WASTEWATER TREATMENT AND DISCHARGE TO CITY SEWER	
NORTHERN OHIO SUGAR COMPANY FREEMONT, OHIO	OPERATIONAL
NORTHERN OHIO SUGAR COMPANY FINDLAY, OHIO	TERMINATED BLEED-OFF STREAM TO HOLDING TANK
WASTEWATER TREATMENT AND DISCHARGE TO RIVER	
GREAT SOUTHERN PAPER CO. CEDAR SPRINGS, GEORGIA	OPERATIONAL CLARIFICATION FOLLOWED BY PONDING AND DISCHARGE TO RIVER
GREAT WESTERN SUGAR BILLINGS, MONTANA	OPERATIONAL
GREAT WESTERN SUGAR FORT MORGAN, COLORADO	OPERATIONAL
GREAT WESTERN SUGAR GERING, NEBRASKA	OPERATIONAL EFFLUENT TO HOLDING POND
GREAT WESTERN SUGAR GREELEY, COLORADO	OPERATIONAL
GREAT WESTERN SUGAR LOVELAND, COLORADO	OPERATIONAL EFFLUENT STREAM TO HOLDING POND
GREAT WESTERN SUGAR SCOTTS BLUFF, NEBRASKA	OPERATIONAL EFFLUENT STREAM TO HOLDING POND.
GREAT WESTERN SUGAR LONGMONT, COLORADO	TERMINATED
TRANSCO TEXTILES, INC. AUGUSTA, GEORGIA	INDEFFINITIELY SHUT DOWN NA2SO3/SO4 LIQUOR DISCHARGED TO A HOLDING POND
WASTEWATER TREATMENT AND DISCHARGE TO TAILINGS POND	
CHEVRON U.S.A. INC. BAKERSFIELD, CALIFORNIA	OPERATIONAL
GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA	OPERATIONAL HOLDING POND FOR EVAPORATION. 9 GPM BLEEDOFF TO A BLOWDOWN TANK. THE BLOWDOWN IS EMPTIED INTO A DISPOSAL POND ONCE A WEEK.
GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA	CONSTRUCTION HOLDING POND FOR EVAPORATION. 9 GPM BLEEDOFF TO A BLOWDOWN TANK. THE BLOWDOWN IS EMPTIED INTO A DISPOSAL POND ONCE A WEEK.
ITT RAYONIER, INC. FERNANDINA BEACH, FLORIDA	OPERATIONAL

SECTION 8 (CONTINUED)

SUMMARY OF DISPOSAL PRACTICES FOR FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME / LOCATION	STATUS/COMMENTS
WASTEWATER TREATMENT	
ALYESKA PIPELINE SERVICE CO. VALDEZ, ALASKA	OPERATIONAL NA2SO3/HSO3 AERATED TO NA2SO4 AND TRANSFERRED TO WASTEWATER TREATMENT PLANT AT A RATE OF 10 GPM. IT IS MIXED WITH ABOUT 10,000 GPM OF BALLAST WATER FROM TANKERS IN PORT VALDEZ. CLEANED WATER IS THEN DISCHARGED INTO PORT VALDEZ.
BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA	OPERATIONAL
BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA	OPERATIONAL
CARBORUNDUM ABRASIVES BUFFALO, NEW YORK	PLANNED-CONTRACT AWARDED
CHEVRON U.S.A. INC. BAKERSFIELD, CALIFORNIA	PLANNED-REQUESTING/EVALUATING BIDS
MINN-DAK FARMER'S CO-OPERATIVE WAHPETON, NORTH DAKOTA	OPERATIONAL BLEED STREAM GOES TO AN ACTIVATED SLUDGE SYSTEM @ 160 GPM ANAEROBIC DIGESTION, FOLLOWED BY AN OPEN POND, FOLLOWED BY AEROBIC DIGESTION.
ST. REGIS PAPER CO. CANTONMENT, FLORIDA	OPERATIONAL EFFLUENT IS TREATED IN AN ON-SITE SEWAGE TREATMENT PLANT
TEXACO INCORPORATED SAN ARDO, CALIFORNIA	OPERATIONAL HALF OF THE SCRUBBER UNDERFLOW IS TREATED AND RECYCLED AS BOILER FEEDWATER; THE OTHER HALF GOES TO WASTEWATER DISPOSAL WELLS.
TEXASGULF GRANGER, WYOMING	OPERATIONAL
OVERFLOW TO SEWER/SLUDGE TO LANDFILL	
SHELLER GLOBE CORP. NORFOLK, VIRGINIA	INDEFINITELY SHUT DOWN
DISPOSAL TECHNIQUE NOT KNOWN	
C.A.M.(CARBIDE-AMOCO-MONSANTO) HOUSTON, TEXAS	PLANNED-CONSIDERING SO2 CONTROL
HARRIS MINING CO. SPRUCE PINE, NORTH CAROLINA	INDEFINITELY SHUT DOWN
SHELL OIL COMPANY BAKERSFIELD, CALIFORNIA	PLANNED-CONSIDERING SO2 CONTROL
SHELL OIL COMPANY TAFT, CALIFORNIA	PLANNED-CONSIDERING SO2 CONTROL
SCRUBBER EFFLUENT DISPOSED OF IN WASTE WELLS	
TEXACO INCORPORATED SAN ARDO, CALIFORNIA	CONSTRUCTION

SECTION 9

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	ALYESKA PIPELINE SERVICE CO.
INSTALLATION LOCATION	VALDEZ, ALASKA
SOURCE CHARACTERISTICS	OIL (0.03% - 0.1% SULFUR)
SOURCE RATING	50,000 SCFM (DESIGN MAXIMUM)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	3
SOURCE CAPACITY	25 MW (EQUIVALENT) (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	JUNE, 1977
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	96+% (150-160 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	PARTICULATE EMISSIONS MEET NSPS.
WATER MAKE-UP	2 GPM - OPEN LOOP
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT NA2SO3/HSO3 AERATED TO NA2SO4 AND TRANSFERRED TO WASTEWATER TREATMENT PLANT AT A RATE OF 10 GPM. IT IS MIXED WITH ABOUT 10,000 GPM OF BALLAST WATER FROM TANKERS IN PORT VALDEZ. CLEANED WATER IS THEN DISCHARGED INTO PORT VALDEZ.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

AT THE VALDEZ TERMINAL OF THE ALASKAN OIL PIPELINE, ALYESKA PIPELINE SERVICE COMPANY OPERATES THE OIL STORAGE AND TRANSFER FACILITY. OIL FLOWING IN FROM THE PIPELINE IS TEMPORARILY STORED IN SEVERAL HUGE TANKS, THEN TRANSFERRED FROM THE TANKS TO OIL TANKER SHIPS IN NEARBY PORT VALDEZ. ALYESKA NEEDED NEUTRAL BLANKET AIR FOR THE OIL STORAGE TANKS, A LOW OXYGEN CONTENT BEING PARTICULARLY DESIRABLE. IT WAS DETERMINED THAT ON-SITE BOILER FLUE GAS WOULD HAVE THE REQUIRED LOW OXYGEN CONTENT. CORROSION PREVENTION IN THE OIL STORAGE TANKS DICTATED THE NEED FOR SO2 CONTROLS. THAT IS, THE DEVICE WAS NOT INSTALLED TO MEET AN EMISSIONS REGULATION. NEVERTHELESS, THE "INERT GAS" SYSTEM IS BASICALLY A SODIUM HYDROXIDE FGD SYSTEM AND WAS DESIGNED AND INSTALLED BY FMC ENVIRONMENTAL EQUIPMENT DIVISION.

THE BOILERS DO NOT OPERATE AT STEADY STATE CONDITIONS. THIS IS DUE TO THE FACT THAT WHEN OIL IS REMOVED FROM THE TANKS AT A FASTER RATE THAN IT IS BEING FED BY THE PIPELINE, AN ADDITIONAL INERT AIR BLANKET IS NEEDED. THIS REQUIRES INCREASING THE BOILER LOAD FROM THE NORMAL LEVEL OF PLANT POWER PRODUCTION TO RUN THE COMPRESSORS AND PRODUCE ADDITIONAL GAS FOR BLANKET PRODUCTION.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

ALYESKA PIPELINE SERVICE CO.: VALDEZ, ALASKA (CONTINUED)

IF THE TANKS ARE FILLING FASTER THAN THEY ARE BEING EMPTIED, THE AIR FORCED OUT BY THE INCOMING OIL IS INCINERATED.

THE BOILER PLANT AT THE VALDEZ TERMINAL CONSISTS OF THREE 250 MM BTU/HR OIL-FIRED BOILERS, MANUFACTURED BY COMBUSTION-ENGINEERING. THE OIL BEING USED IN THE BOILERS PRODUCES A VERY LOW PARTICULATE GRAIN LOADING, AND HAS AN EXTREMELY LOW SULFUR CONTENT WHICH RANGES FROM 0.03% TO 0.1%. THERE IS NO PARTICULATE CONTROL OTHER THAN WHAT OCCURS IN THE FMC SO_2 ABSORBER MODULE.

THE MAXIMUM DESIGN CAPACITY OF THE SCRUBBER MODULE IS 50,000 SCFM, WHICH REPRESENTS ABOUT 25% OF THE TOTAL FLUE GAS GENERATED. THE SO_2 CONTROL SYSTEM IS DESIGNED WITH 100% REDUNDANCY, I.E., THERE ARE TWO MODULES IN PARALLEL, ONLY ONE OF WHICH IS IN USE AT ANYTIME. THE MODULES ARE IDENTICAL 4-STAGE DISH-AND-DONUT TRAY TYPE ABSORBERS WITH A MAXIMUM RECIRCULATION RATE OF 600 GPM AND A L/G RATIO OF 12 GAL/1000 CU FT.

CAUSTIC (SODIUM HYDROXIDE) IS USED AS REAGENT MAKE-UP. DESIGN PH CONTROL WAS ABOUT 6.5, BUT OPERATIONS HAVE INDICATED THAT A HIGHER PH IS MORE DESIRABLE, SO CONTROL PH IS NOW ABOUT 8.0. A BLEED STREAM OF SODIUM BISULFITE/SULFITE GOES TO AN AERATOR AT A RATE OF 10 GPM. AFTER COMPLETE OXIDATION TO NA_2SO_4, THE WASTE STREAM GOES TO A WASTEWATER TREATMENT AREA WHERE IT IS MIXED WITH 10,000 GPM OF BALLAST WATER FROM THE TANKERS IN THE PORT, AND DISCHARGED INTO THE PORT.

REFER TO FIGURE 14-1 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1977 CORROSION HAS OCCURRED IN THE PIPING FOR THE WATER RECIRCULATION SYSTEM. AT THE TIME OF THIS REPORT, THE CAUSE WAS NOT KNOWN. ALYESKA TESTS HAVE DEMONSTRATED ABOUT 5 PPM $SO_2/SO_3/SO_4$ AT THE ABSORBER OUTLET. INLET SO_2 CONCENTRATION RANGES FROM 150 TO 160 PPM. THE SYSTEM WAS THEREFORE REMOVING ABOUT 96% OF THE INLET SULFUR OXIDES. AT THE TIME OF THIS REPORT, THERE WAS NO CONTINUOUS SO_2 MONITOR ON THE SYSTEM.

4TH QUARTER-1977 THE CONTROL SYSTEM OPERATED NEARLY PROBLEM-FREE, WITH NO DOWNTIME BEING ASSIGNED TO THE SO_2 REMOVAL SYSTEM. THE CURRENT LOAD IS APPROXIMATELY 20% OF DESIGN CAPACITY. THIS IS A RESULT OF OIL FLOW BEING LOW AT PRESENT. PLANS WERE BEING MADE TO DEAL WITH THE WET AREAS CORROSION PROBLEM BY INTRODUCING NEUTRALIZING AMINE SPRAYS.

1ST QUARTER-1978 DURING THIS PERIOD, THE CORROSION PROBLEM WAS ALLEVIATED BY SPRAYING HYDRAZINE INTO THE SYSTEM UPSTREAM OF THE MIST ELIMINATOR. THIS MEASURE RAISED FROM 4 TO 6.5 THE PH OF THE LIQUOR RECOVERED BY THE MIST ELIMINATOR. CYCLOHEXYLAMINE MAY BE TESTED IN PLACE OF THE HYDRAZINE. THE PLANT WAS NOT YET AWARE OF THE CAUSE OF THE CORROSION, ALTHOUGH THEY SUSPECTED CARBON, SULFUR, AND NITROGEN ACID GASES. CHLORIDES HAVE VIRTUALLY BEEN RULED OUT AS THE SOURCE OF THE CORROSION.

2ND QUARTER-1978 THE FMC FGD SYSTEM CONTINUED TO OPERATE ON A CONTINUOUS BASIS, BEING RESPONSI-

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

ALYESKA PIPELINE SERVICE CO.: VALDEZ, ALASKA (CONTINUED)

BLE FOR NO DOWNTIME. ANY MAINTENANCE OPERATIONS WERE EFFECTED WHILE THE SYSTEM WAS OPERATING. IT IS IMPORTANT TO NOTE AGAIN THAT THE SYSTEM IS DESIGNED WITH 100% REDUNDANCY.

3RD QUARTER-1978 THE SYSTEM CONTINUED TO DEMONSTRATE 100% AVAILABILITY DURING THIS PERIOD. CYCLOHEXYLAMINE IS NOW BEING USED INSTEAD OF HYDRAZINE TO CONTROL PH DOWNSTREAM OF THE ABSORBER. PH IS NOW IN THE 6-7 RANGE AND CORROSION SEEMS TO HAVE STOPPED. IF FURTHER CONTROL OF PH IS NEEDED, ADDITIONAL CYCLOHEXYLAMINE SPRAY POINTS MAY BE INSTALLED.

4TH QUARTER-1978 SYSTEM AVAILABILITY FOR THIS PERIOD CONTINUED TO BE 100%. CYCLOHEXYLAMINE WILL CONTINUE TO BE SPRAYED INTO THE FLUE GAS EXITING THE SCRUBBER. THIS RAISES THE PH OF THE ENTRAINED LIQUID AND HAS STOPPED THE ACID CORROSION IN THE CARBON STEEL OIL STORAGE TANKS. PRIOR TO THE ADDITION OF THE AMINE SPRAYS, THE TANKS WERE CORRODING AT A RATE OF ABOUT 40 MILS PER YEAR.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	AMERICAN THREAD CO.
INSTALLATION LOCATION	MARION, NORTH CAROLINA
SOURCE CHARACTERISTICS	COAL (1 - 1.5% SULFUR)
SOURCE RATING	18,500 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	9 MW (EQUIVALENT); TOTAL 2 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	W.W. SLY MANUFACTURING CO.
CONTROL PROCESS	CAUSTIC WASTE STREAM
NEW / RETROFIT	RETROFIT
START-UP DATE	1973
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	70% (500 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	97%
SLUDGE OR BY-PRODUCT DISPOSAL	HOLDING POND FOR EVAPORATION THE SODIUM SULFITE/SULFATE WASTE LIQUOR IS PUMPED TO A RED CLAY LINED ASH BASIN. LEACHING OF THE SOLUBLE SODIUM SALTS IS THEREBY PREVENTED.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

AMERICAN THREAD COMPANY, LOCATED IN MARION, NORTH CAROLINA OPERATES TWO COAL-FIRED BOILERS, EACH WITH A DESIGN CAPACITY OF 30,000 ACFM @ 400 F. DURING THE WINTER MONTHS ONE BOILER IS OPERATED 7 DAYS/WEEK AT 75% LOAD AND THE OTHER OPERATED 5 DAYS/WEEK ALSO AT 75% LOAD. BOTH BOILERS OPERATE 5 DAYS/WEEK AT 50% LOAD DURING THE SUMMER MONTHS.

THE SCRUBBERS WERE SUPPLIED BY W.W. SLY MANUFACTURING CO. AND WERE ORIGINALLY INSTALLED TO CONTROL PARTICULATE. EACH IS CONSTRUCTED OF 304 SS AND 316 SS WITH SPRAY NOZZLES OF 304 SS. EACH SCRUBBER IS 10 FEET IN DIAMETER AND 12 FEET HIGH WITH TWO SPRAY LEVELS AND HAS A PRESSURE DROP OF 6 IN. W.C. AT FULL LOAD. THE FLUE GAS ENTERS EACH SCRUBBER AT A RATE OF 30,000 ACFM @ 350 F AND LEAVES AT 160 F.

THE SCRUBBING LIQUOR IS A 7% CAUSTIC WASTE STREAM FROM A MERCERIZING STEP IN WHICH THREAD IS CLEANED AND SHRUNK. THE CONTROL PH IS 8.5 IN THE RECIRCULATION TANK. SPENT LIQUOR ENTERING THE TANK IS AT A PH OF 2.5. THE SCRUBBERS HAVE BEEN EXHIBITING 90% RELIABILITY. RECIRCULATION AND SLUDGE HANDLING PUMPS ARE MADE OF RUBBER-LINED CAST IRON.

A 35-40% BLEED STREAM FROM THE RECIRCULATION TANK REMOVES WASTE SOLIDS TO AN ASH POND FOR SETTLING.

AMERICAN THREAD CO.; MARION, NORTH CAROLINA (CONTINUED)

REFER TO FIGURE 14-2 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

2ND QUARTER-1978 PLANT REPORTS THAT IT IS STILL EXPERIENCING SCRUBBER I.D. FAN PROBLEMS DUE TO VIBRATION AND CORROSION. TO OVERCOME THIS PROBLEM, PLANS ARE BEING MADE TO ELIMINATE THE I.D. FANS ON THE SCRUBBER AND UPGRADE BOILER I.D. FANS.

OTHER PROBLEMS HAVE BEEN AS FOLLOWS:

1. VIBRATION CRACKS IN PVC PIPING.
2. FAILURE OF PUMP RUBBER LINING.
3. THE NEED TO DRAIN THE RECIRCULATION TANK AND PAINT IT WITH EPOXY PAINT TO ALLEVIATE CORROSION PROBLEMS.

3RD QUARTER-1978 THE VIBRATION CRACKS IN THE PVC PIPING ARE LOCATED AT THE ENTRANCE TO THE SCRUBBER AND WERE CAUSED BY AN UNBALANCED FAN. THE FAN BECAME UNBALANCED WHEN ITS FIBERGLASS COATING WAS ERODED AWAY. TWO WEEKS WERE REQUIRED TO PATCH THE COATING. THE CRACKED PIPE SECTIONS WERE REPLACED. PLANS ARE BEING MADE TO REMOVE THE SCRUBBER I.D. FAN COMPLETELY FROM THE SYSTEM AND TO UPGRADE THE EXISTING BOILER I.D. FAN SO THAT IT HAS THE CAPACITY TO OVERCOME THE SCRUBBER SYSTEM PRESSURE DROP.

THE REPLACEMENT OF A PUMP LINING CAUSED THREE DAYS DOWNTIME.

EPOXY PAINT USED ON THE RECIRCULATION TANK WAS INEFFECTIVE. ONE-HALF INCH PLATES WERE WELDED TO THE TANK TO PATCH HOLES CAUSED BY THE CORROSIVE LIQUOR. THE SCRUBBER WAS DOWN FOR A WEEK. CORROSION OF PRESSURE GAUGES AND COPPER LINES HAS ALSO BEEN A PROBLEM AREA.

4TH QUARTER-1978 DURING THE REPORT PERIOD THE BOILERS OPERATED 5 DAYS/WEEK, 24 HOURS A DAY. THE PATCH-UP WORK ON FIBERGLASS COATING OF ID FAN ROTORS CAUSED TWO DAYS OF SCRUBBER DOWNTIME. FOUR OF THE LOWER LEVEL SPRAY NOZZLES (304 SS) EXPERIENCED EROSION DUE TO THE ABRASIVE FLYASH AND WERE REPLACED. RECIRCULATION TANKS AND PUMPS HAD NO OPERATING PROBLEMS. THE RELIABILITY INDEX OF SCRUBBERS IMPROVED TO A VALUE OF ABOUT 96%.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	ARMCO STEEL
INSTALLATION LOCATION	MIDDLETOWN, OHIO
SOURCE CHARACTERISTICS	COAL (0.8% SULFUR)
SOURCE RATING	84,000 SCFM (TOTAL - 2 BOILERS) 200,000 LB/HR STEAM (TOTAL)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	42 MW (EQUIVALENT); TOTAL - 2 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	KOCH ENGINEERING
CONTROL PROCESS	LIME SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	NOT AVAILABLE
SLUDGE OR BY-PRODUCT DISPOSAL	HOLDING POND FOR EVAPORATION
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

ARMCO STEEL, MIDDLETOWN OPERATES TWO MULTI-RETORT, UNDERFEED STOKER, COAL-FIRED BOILERS, EACH WITH A CAPACITY OF 100,000 LBS/HR STEAM. THE COAL BURNED IS TYPICALLY 0.7% TO 0.9% SULFUR AND 8% TO 10% ASH. INITIALLY THE BOILERS WERE OPERATED IN THE WINTER MONTHS ONLY, HOWEVER BEGINNING IN 1976, OPERATIONS WERE YEAR-ROUND WITH REDUCED CAPACITY DURING THE SUMMER.

THE CONTROL SYSTEM CONSISTS OF A VARIABLE-THROAT VENTURI SCRUBBER WITH A PRESSURE DROP-CONTROLLED, ADJUSTABLE PLUG. IMMEDIATELY DOWNSTREAM FROM THE VENTURI IS AN ABSORBER MODULE 17 FEET IN DIAMETER WITH THREE GAS SCRUBBING TRAYS, AN S-TYPE CHEVRON MIST ELIMINATOR AND A 106-INCH DIAMETER STUB STACK. THE SYSTEM IS DESIGNED TO HANDLE 140,000 ACFM AT 425 F AND 15 INCHES WG WITH AN OUTLET LOADING OF 0.02 GR PER SCFD. FRESH WATER IS SUPPLIED FROM CLARIFIED RIVER WATER AT THE RATE OF 1600 GPM TO THE TOP TRAY AND VENTURI THROAT. A LIME SLURRY IS ADDED IN A 10,000 GALLON RECYCLE TANK WHICH HOLDS EFFLUENT FROM THE ABSORBER MODULE. THE DESIGN L/G RATIO IS 11.4 GALLONS PER 1000 ACF.

A PH OF APPROXIMATELY 7 IS MAINTAINED IN THE RECYCLE TANK. IF PH VARIES MORE THAN TWO-TENTHS OF A PH UNIT (6.8-7.2), A LIGHT/BUZZER ALERTS THE OPERATORS WHO ADJUST THE PH BY OPENING OR CLOSING A VALVE LEADING FROM THE LIME SLURRY HOLDING TANK TO THE RECYCLE TANK.

THE LARGEST PROBLEM AFFECTING SCRUBBER PERFORMANCE HAS BEEN CONTROL OF EXCESS AIR IN THE BOILERS. WITHOUT CONTROL, EXCESS AIR RESULTS IN 1.5 TO 3 TIMES THE SCRUBBER DESIGN FLOW RATE. THESE HIGH EXCESS AIR RATES ALSO RESULT IN THE PRESENCE OF UNBURNED CARBON WHICH COULD NOT BE SCRUBBED AND

ARMCO STEEL: MIDDLETOWN, OHIO (CONTINUED)

COMPOUNDED POOR PERFORMANCE.

OPERATING HISTORY

1ST/2ND/3RD QUARTER-1977 PROBLEMS OCCURRED WITH THE CHEVRON MIST ELIMINATOR WHICH IS MADE OF NOREL PLASTIC. IT WAS RATED AT 225 F WHICH WAS WELL ABOVE THE TEMPERATURE AT THAT LOCATION IN THE SYSTEM. HOWEVER, OVERLOOKED WAS THE FACT THAT NOREL IS CREEP SENSITIVE AT 20 DEGREES F ABOVE AMBIENT AND THE CHEVRONS FAILED WITHIN A FEW MONTHS. NEW CHEVRONS OF THE SAME MATERIAL ARE ALSO BEING DAMAGED. STAINLESS STEEL OR FIBERGLASS REINFORCED PLASTIC IS THE PREFERRED MATERIAL FOR THIS APPLICATION.

THE WATER SYSTEM WAS ORIGINALLY DESIGNED TO BE A RECIRCULATING SYSTEM. THE RECIRCULATED WATER HAD A SUSPENDED SOLIDS CONCENTRATION OF 40,000-50,000 MG/L AT THE VENTURI. ALL THE PIPING IN THIS SYSTEM WAS MILD STEEL AND WAS SEVERLY ABRADED CAUSING NUMEROUS LEAKS.

THE SYSTEM HAS BEEN MODIFIED TO A ONCE-THROUGH OPERATION AND THE ABRASION HAS CEASED. SERIOUS ABRASION PROBLEMS WERE ALSO ENCOUNTERED IN 12-INCH STEEL PIPING CARRYING DIRTY WATER FROM THE TRAYS TO THE RECYCLE TANK AS WELL AS IN THE PUMPS. THE PROBLEM WAS SOLVED BY REPLACING THE PIPING WITH RUBBER HOSE, RUBBER LINED ELBOWS, AND RUBBER LINED PUMPS. IN ADDITION, PUMP SPEED WAS REDUCED FROM 1780 TO 1180 RPM AND FLANGED T-SECTIONS WERE INSTALLED ON THE SUCTION SIDE OF THE SLUDGE PUMPS AND RECIRCULATION PUMPS. THIS MATERIAL HAS WITHSTOOD ABRASION BETTER THAN ANY OTHER MATERIAL TRIED TO DATE.

A LIME BUILD UP PROBLEM WAS EXPECTED ON THE ABSORBER TRAYS AT LOW GAS FLOW RATES. THIS PROBLEM HAS NOT YET OCCURRED AT SUSTAINED PH LEVELS OF 6-6.5.

THE LIME SLURRY SYSTEM HAS ALSO PRESENTED A PROBLEM. CLOGGING OF THE LIME SLURRY LINE IS ATTRIBUTED TO ITS EXCESSIVE LENGTH. LIME ADDITION RATE IS A PROBLEM WHICH CAN BE RESOLVED WITH THE INSTALLATION OF A PROPORTIONAL LIME SLAKER.

REFER TO FIGURE 14-4 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

4TH QUARTER-1977 THE PLANT WAS NOT ABLE TO SUPPLY EXTENSIVE UPDATE INFORMATION FOR THIS REPORT PERIOD, ALTHOUGH REPORTED THAT RECENT OPERATIONS HAVE BEEN RELATIVELY PROBLEM-FREE. THE SCRUBBER WAS DOWN IN FEBRUARY 1978 AS A RESULT OF THE POWER SHORTAGE OHIO WAS EXPERIENCING.

2ND QUARTER-1978 NO INFORMATION WAS OBTAINED FOR THIS UPDATE.

3RD QUARTER-1978 ABRASION CONTINUES TO BE A PROBLEM. NEW RUBBER LININGS FABRICATED IN ARMCO'S ON-SITE RUBBER SHOP WILL BE INSTALLED. FIBERGLASS-LINED PIPE WAS ON ORDER.

ARMCO STEEL: MIDDLETOWN, OHIO (CONTINUED)

THE EXCESS AIR PROBLEM HAS BEEN REDUCED TO ABOUT 40% BY PATCHING LEAKS FOUND ON THE BOILER AND REDUCING THE COMBUSTION AIR TO THE BOILER. HOWEVER, DUE TO THE AGE AND CONDITION OF THE BOILER IT IS NOT LIKELY THAT THE EXCESS AIR WILL BE REDUCED FURTHER. THE BOILER IS OPERATED AN ESTIMATED 10 MO/YR. THE SCRUBBER NORMALLY OPERATES APPROXIMATELY 2 TO 3 MONTHS BEFORE IT HAS TO BE SHUT DOWN FOR REPAIRS. THE PLANNED PROPORTIONAL LIME SLAKER WAS NEVER INSTALLED.

4TH QUARTER-1978 ABRASION CONTINUES TO BE A MAJOR PROBLEM. NO OTHER INFORMATION WAS MADE AVAILABLE AT THIS TIME DUE TO POSSIBLE LITIGATION CONCERNING NEWLY PROPOSED EMISSION STANDARDS. THE NEW STANDARDS ARE BEING SET ON A STACK-BY-STACK BASIS.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	BELRIDGE OIL CO.
INSTALLATION LOCATION	MCKITTRICK, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.1% SULFUR)
SOURCE RATING	12,000 SCFM (1 BOILER) 24,000 ACFM @ 570 F
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	6 MW (EQUIVALENT) 50 MM BTU/HR (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	HEATER TECHNOLOGY
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	JUNE, 1978
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90% (500 PPM SO2 AT INLET)
WATER MAKE-UP	15 GPM
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

BELRIDGE OIL COMPANY HAS AN ENHANCED OIL RECOVERY SITE IN MCKITTRICK, CALIFORNIA. THERE ARE SEVERAL SMALL STEAM GENERATORS, EACH RATED AT 50 MM BTU/HR, WHICH BURN A PART OF THE OIL PRODUCED BY THE RECOVERY OPERATIONS. THE CRUDE OIL HAS 1.1 PERCENT SULFUR.

THE FGD SYSTEM, WHICH WAS SUPPLIED NEW BY HEATER TECHNOLOGY IN JULY 1978, TREATS A FLUE GAS FLOW OF 24,000 ACFM AT 570 F. THE SYSTEM CONSISTS OF AN EDUCTOR-TYPE VENTURI MOUNTED ON ONE SIDE OF A RECYCLE TANK, AND A STUB STACK MOUNTED ON THE OTHER. THE VENTURI HAS AN ADJUSTABLE DISK, WHICH FORMS THE CONTACT STAGE FOR THE GAS AND RECIRCULATING LIQUOR. THE GAS THEN FLOWS THROUGH THE MIST ELIMINATOR HOUSED INSIDE THE STUB STACK. THE LIQUOR, DISENGAGED FROM THE GAS, IS RECIRCULATED WITH A CONSTANT BLEED-OFF OF 10 GPM. THE DESIGN L/G RATIO IS 40 GAL/1000 ACF. THE PROCESS USED IS SODIUM HYDROXIDE SCRUBBING AND FRESH CAUSTIC MAKEUP IS ADDED TO THE RECYCLE TANK. THE VENTURI SECTION, CONTACTING DISC, RECIRCULATING PIPING AND THE RECIRCULATING PUMP ARE MADE OF 316L SS. THE RECYCLE TANK IS CARBON STEEL WITH EPOXY TAR COATING AND THE MIST ELIMINATOR IS FRP. THE PRESSURE DROP ACROSS THE ENTIRE SYSTEM IS LESS THAN THE VACUUM CREATED BY THE EDUCTOR, ABOUT 1 IN. W.G.

THE BLEED-OFF STREAM IS TAKEN TO WASTEWATER TREATMENT. IN ADDITION, IT IS NECESSARY TO BLOW DOWN FROM THE RECYCLE TANK INTERMITTENTLY.

BELRIDGE OIL CO.; MCKITTRICK, CALIFORNIA (CONTINUED)

OPERATING HISTORY

3RD QUARTER-1978 SINCE FGD SYSTEM START-UP ON JULY 6, 1978 THE SCRUBBER HAS EXPERIENCED APPROXIMATELY 1 1/2 WEEKS OF DOWNTIME. MAJOR PROBLEMS HAVE BEEN FAULTY RELAYS IN THE INSTRUMENTATION, AND PUMP FAILURE. THE RECIRCULATION PUMP WAS REPLACED.

4TH QUARTER-1978 THE SCRUBBER OPERATED 95 DAYS OUT OF 105 DAYS OF GENERATOR OPERATIONS. THIS CORRESPONDS TO AN AVAILABILITY OF 89 PERCENT. SEVERE VIBRATIONS IN THE RECIRCULATION PUMP CAUSED FAILURE OF THE RECYCLE PIPING. THE PUMP FOUNDATION WAS REINFORCED AND THE PIPING WAS REPLACED. LEAKS IN CAUSTIC LINES WERE ALSO A PROBLEM AREA.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	BELRIDGE OIL CO.
INSTALLATION LOCATION	MCKITTRICK, CALIFORNIA
SOURCE CHARACTERISTICS	CRUDE OIL (1.1% SULFUR)
SOURCE RATING	12,000 SCFM 24,000 ACFM @ 570 F
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	5000 LB/HR STEAM 6 MW (EQUIVALENT) 50 MM BTU/HR; 50,000 LB/HR STEAM (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	THERMOTICS INC.
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	JULY, 1978
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90% (500 PPM SO2 @ INLET)
WATER MAKE-UP	15 GPM
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

BELRIDGE OIL COMPANY HAS AN ENHANCED OIL RECOVERY SITE IN MCKITTRICK, CALIFORNIA. THERE ARE SEVERAL SMALL STEAM GENERATORS, EACH RATED AT 50 MM BTU/HR, WHICH BURN A PART OF THE OIL PRODUCED BY THE RECOVERY OPERATIONS. THE CRUDE OIL HAS 1.1 PERCENT SULFUR.

THE FGD SYSTEM, WHICH WAS SUPPLIED NEW BY THERMOTICS INC. IN JULY 1978, TREATS A FLUE GAS FLOW OF 24,000 ACFM AT 570 F. THE SYSTEM CONSISTS OF AN EDUCTOR-TYPE VENTURI MOUNTED ON ONE SIDE OF A RECYCLE TANK, AND A STUB STACK MOUNTED ON THE OTHER. THE VENTURI HAS AN ADJUSTABLE DISK, WHICH FORMS THE CONTACT STAGE FOR THE GAS AND RECIRCULATING LIQUOR. THE GAS THEN FLOWS THROUGH THE MIST ELIMINATOR HOUSED INSIDE THE STUB STACK. THE LIQUOR, DISENGAGED FROM THE GAS, IS RECIRCULATED WITH A CONSTANT BLEED-OFF OF 10 GPM. THE DESIGN L/G RATIO IS 40 GAL/1000 ACF. THE PROCESS USED IS SODIUM HYDROXIDE SCRUBBING AND FRESH CAUSTIC MAKEUP IS ADDED TO THE RECYCLE TANK. THE VENTURI SECTION, CONTACTING DISC, RECIRCULATING PIPING AND THE RECIRCULATING PUMP ARE MADE OF 316L SS. THE RECYCLE TANK IS CARBON STEEL WITH EPOXY TAR COATING AND THE MIST ELIMINATOR IS FRP. THE PRESSURE DROP ACROSS THE ENTIRE SYSTEM IS LESS THAN THE VACUUM CREATED BY THE EDUCTOR, ABOUT 1 IN W.G.

THE BLEED-OFF STREAM IS TAKEN TO WASTEWATER TREATMENT. IN ADDITION, IT IS NECESSARY TO BLOW DOWN THE RECYCLE TANK INTERMITTENTLY.

BELRIDGE OIL CO.: MCKITTRICK, CALIFORNIA (CONTINUED)

THE FGD SYSTEM HAS THE ADVANTAGES OF SIMPLE DESIGN AND NO REQUIREMENT OF A FAN. ON THE OTHER HAND, THE COCURRENT, SINGLE-STAGE CONTACT NECESSITATES HIGH PH (ABOUT 8.0) IN THE RECIRULATING LOOP IF THE SO2 REMOVAL IS TO EXCEED 90 PERCENT. THIS LEADS TO HIGHER CONSUMPTION OF THE ALKALI. THE INTERMITTENT BLOWDOWN OF THE RECYCLE TANK RESULTS IN CORRESPONDING GENERATOR DOWNTIME.

OPERATING HISTORY

3RD QUARTER-1978 SINCE FGD SYSTEM START-UP ON JULY 6, 1978 THE SCRUBBER HAS EXPERIENCED APPROXIMATELY 1 1/2 WEEKS OF DOWNTIME. MAJOR PROBLEMS HAVE BEEN FAULTY RELAYS IN THE INSTRUMENTATION, AND PUMP FAILURE. THE RECIRCULATION PUMP WAS REPLACED.

4TH QUARTER-1978 THE SCRUBBER OPERATED 98 DAYS OUT OF 105 DAYS OF GENERATOR OPERATIONS. THIS CORRESPONDS TO AN AVAILABILITY OF 93 PERCENT. ELECTRICAL CONNECTION MALFUNCTIONS AND LEAKS IN CAUSTIC FEED LINE WERE THE MAJOR PROBLEMS. THE RECIRCULATION PUMP SEAL REQUIRED REPLACEMENT.

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CANTON TEXTILES
INSTALLATION LOCATION	CANTON, GEORGIA
SOURCE CHARACTERISTICS	COAL (0.8% SULFUR) INTERRUPTIBLE NATURAL GAS
SOURCE RATING	25,000 SCFM (1 BOILER)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	13 MW (EQUIVALENT) (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	CAUSTIC WASTE STREAM
NEW / RETROFIT	RETROFIT
START-UP DATE	JUNE, 1974
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	70% (500 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	80% - 90% (5.92 LB/MM BTU AT INLET)
WATER MAKE-UP	OPEN LOOP
SLUDGE OR BY-PRODUCT DISPOSAL	NON-FIXATED SLURRY TO LINED POND NA SO3/SO4 LIQUOR DISPOSED TO LINED HOLDING PONDS
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

CANTON TEXTILE MILLS IN CANTON, GEORGIA HAS A 13 MW (EQUIVALENT) STEAM BOILER WHICH FIRES COAL FROM OCTOBER TO MAY AND INTERRUPTIBLE NATURAL GAS THE REMAINDER OF THE YEAR. THE BOILER IS A COMBUSTION ENGINEERING (C-E) VERTICAL UNIT EQUIPPED WITH A CYCLONIC DUST COLLECTOR. THE DUST COLLECTOR CAPTURES APPROXIMATELY 75 TO 100 POUNDS OF FLY ASH PER HOUR. THE TYPICAL COAL BURNED HAS A SULFER CONTENT OF 0.8 PERCENT AND AN AS-RECEIVED HEAT VALUE OF 13,600 BTU PER POUND OF COAL. SULFER DIOXIDE CONCENTRATION IN THE FLUE GAS IS 500 PPM WITH A PARTICULATE LOADING OF 5.92 LB/MM BTU.

THE FGD SYSTEM, DESIGNED BY R.S. NOONAN, INC., CONSISTS OF AN FMC MEDIUM ENERGY, VENTURI-TYPE SCRUBBER MADE OF 316L SS AND A SEPARATOR (8 FT DIA x 12 FT HIGH) OF FRP. THE FLUE GAS ENTERS THE VENTURI (PRESSURE DROP-6 TO 12 IN W.G.) AT A RATE OF 42,000 ACFM @ 430 F THROUGH A 30 HP. BUFFALO FORCE FD FAN. THE DUCTING LEADING TO AND FROM THE SCRUBBER IS MADE OF 1/4 IN. 316L SS, AND FRP RESPECTIVELY. THE FLUE GAS LEAVES THE SYSTEM THROUGH AN FRP STACK. DYEING WASTE WATER CONTAINING SODIUM SULFATE WITH A PH OF APPROXIMATELY 10.5 TO 12 IS THE SCRUBBING LIQUOR. THE SCRUBBING LIQUOR IS INJECTED INTO THE FLUE GAS STREAM THROUGH 1 IN. DIA. 316L SS SPRAY NOZZELS AHEAD OF THE VENTURI THROAT. THE WASTEWATER IS COLLECTED IN AN EQUALIZATION BASIN. DEPENDING ON THE DESIRED DEGREE OF NEUTRALIZATION, THE WASTEWATER IS THEN RECYCLED TO THE SCRUBBER OR PUMPED TO THE WASTEWATER TREAT-

CANTON TEXTILES: CANTON, GEORGIA (CONTINUED)

MENT FACILITY. A PH LEVEL OF 8.0 IS OBTAINED IN THE FRP RECIRCULATION TANK. THE ALLIS CHALMERS RECIRCULATION PUMP IS MADE OF RUBBER LINED CAST IRON WHILE DYE RETENTION TANK IS OF CONCRETE.

OPERATING HISTORY

SEVERAL OPERATIONAL PROBLEMS WERE ENCOUNTERED UPON INITIAL STARTUP. A SEVERE PLUGGING PROBLEM WAS ENCOUNTERED IN SEVERAL PUMPS DUE TO THE PRESENCE OF COTTON FIBERS IN THE WASTEWATER. A SCREEN BASKET AROUND THE INITIAL SCRUBBER SYSTEM INTAKE PIPE IN THE DYE COLLECTION MANHOLE WAS BEING USED TEMPORARILY UNTIL FURTHER INVESTIGATION IS COMPLETED. SURFACE-ACTIVE AGENTS IN THE DYEING WASTEWATERS WHICH PRODUCE FOAMING IN THE SCRUBBER PUMP WERE DETECTED AND A DEFOAMER ADDITIVE IS NOW INJECTED INTO THE SCRUBBER FEED FROM THE DYE RETENTION BASIN. FOULING OF THE PH PROBES AND MIST CARRYOVER ARE OTHER PROBLEM AREAS THAT HAVE BEEN INVESTIGATED.

REFER TO FIGURE 14-5 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1977   NO OPERATIONAL PROBLEMS WERE REPORTED DURING THIS SURVEY PERIOD. THE PLANT REPORTED THE SYSTEM WAS WORKING SATISFACTORILY. THE PLANT WAS BURNING NATURAL GAS BUT EXPECTED TO RETURN TO COAL DURING THE HEATING SEASON (DECEMBER-MAY).

4TH QUARTER-1977   THE PLANT STARTED BURNING COAL AND OPERATING THE SCRUBBER 100 PERCENT OF THE TIME IN MID-OCTOBER. NO OPERATIONAL PROBLEMS WERE ENCOUNTERED DURING THIS PERIOD.

1ST QUARTER-1978   THE SCRUBBER DEMONSTRATED AN OPERABILITY OF 100%.

2ND QUARTER-1978   THE SCRUBBER WAS SHUTDOWN IN MID-MAY WHEN GAS FIRING RESUMED FOR SUMMER. COAL-FIRING WILL RESUME IN MID-OCTOBER. DURING COAL-FIRED OPERATIONS IN 1977 AND 1978, THE SCRUBBER RAN AT A 100% OPERABILITY.

3RD QUARTER-1978   NO UPDATE INFORMATION WAS AVAILABLE FOR THIS REPORT PERIOD.

4TH QUARTER-1978   COAL FIRING RESUMED IN MID-OCTOBER, AND WILL CONTINUE FOR THE REST OF WINTER MONTHS. DURING THIS SURVEY PERIOD (6 DAYS PER WEEK), THE SCRUBBERS OPERATED AT 99% RELIABILITY. THE DOWNTIME OF 10 HOURS WAS CAUSED BY BUILD-UP OF ABRASIVE FLYASH IN THE SCRUBBER. THE INTERIOR OF THE SCRUBBER WAS THEN CLEANED. THE 316L SS DUCTWORK ENTERING THE SCRUBBER IS AFFECTED BY FLYASH EROSION AND WILL BE REPLACED WITHIN A YEAR. NO OTHER OPERATING PROBLEMS WERE REPORTED.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CATERPILLAR TRACTOR CO.
INSTALLATION LOCATION	EAST PEORIA, ILLINOIS
SOURCE CHARACTERISTICS	COAL (3.2% SULFUR)
SOURCE RATING	210,000 SCFM (TOTAL - 4 BOILERS) 80,000 ACFM @ 350 F, FOR EACH OF 4 FGD SYSTEMS
NUMBER OF SEPARATE FGD UNITS	4
NUMBER OF BOILERS BEING CONTROLLED	4
SOURCE CAPACITY	105 MW (EQUIVALENT); TOTAL - 4 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	DOUBLE ALKALI (CONCENTRATED)
NEW / RETROFIT	2 NEW, 2 RETRO
START-UP DATE	APRIL, 1978
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90% (2,000 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL 60+% SOLIDS (CASO4) SLUDGE DIRECTLY TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE CATERPILLAR TRACTOR COMPANY PLANT LOCATED IN EAST PEORIA, ILLINOIS HAS FOUR COAL-FIRED BOILERS. TWO OF THE BOILERS ARE RATED AT 200,000 POUNDS OF STEAM PER HOUR AND THE REMAINING TWO ARE RATED AT 210,000 POUNDS OF STEAM PER HOUR. THE COAL BURNED IS ILLINOIS COAL WITH A HEATING VALUE OF 10,500 BTU/LB AND AN AVERAGE SULFUR CONTENT OF 3.2%. THE TOTAL BOILER CAPACITY IS ABOUT 100 MW (EQUIVALENT). MECHANICAL COLLECTORS ARE USED FOR PRIMARY PARTICULATE CONTROL. GASES EXHAUST THROUGH A LINED STACK WHICH IS APPROXIMATELY 175 FT TO 180 FT HIGH. THE STACK CONSISTS OF TWO KIDNEY SHAPED FLUES EMBODIED WITHIN ONE OUTER SHELL.

THE AIR QUALITY CONTROL SYSTEMS HAVE BEEN SUPPLIED BY FMC ENVIRONMENTAL EQUIPMENT DIVISION. THERE IS ONE SCRUBBER TRAIN FOR EACH OF THE FOUR BOILERS, WHICH CONTROLS BOTH PARTICULATE AND SO2 EMISSIONS FROM ABOUT 90,000 ACFM @ 425 F. THE FOUR FGD SYSTEMS SHARE COMMON REGENERATION FACILITIES, VACUUM FILTERS, AND SLUDGE DISPOSAL.

REFER TO FIGURE 14-7 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

4TH QUARTER-1977	START-UP WAS SCHEDULED FOR MARCH 1978 AND CONSTRUCTION WAS PROGRESSING SMOOTHLY.
1ST QUARTER-1978	CONSTRUCTION OF THE FOUR FGD SYSTEMS WAS COMPLETED. START-UP WAS DELAYED DUE

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

CATERPILLAR TRACTOR CO.; EAST PEORIA, ILLINOIS (CONTINUED)

TO THE COAL SHORTAGE.

2ND QUARTER-1978 DURING THIS REPORT PERIOD START-UP OCCURRED. BECAUSE THE BOILER PLANT WAS NEAR THE END OF THE HEATING SEASON, THE BOILER LOADS WERE IN THE 70,000-100,000 LB/HR STEAM RANGE. DURING COLD WEATHER OPERATIONS, THE BOILER LOADS ARE APPROXIMATELY 800,000 LB/HR. THE SYSTEM WAS BUILDING GOOD FILTER CAKE DURING THE START-UP PHASE OF OPERATIONS. FINAL STEADY STATE OPERATIONS WERE NOT ACHIEVED BEFORE SUMMER SHUTDOWN.

3RD QUARTER-1978 THE FGD SYSTEM HAD JUST STARTED UP AGAIN AFTER SUMMER SHUTDOWN. NO MAJOR START-UP PROBLEMS WERE REPORTED.

4TH QUARTER-1978 PLANT PERSONNEL REPORT THAT AN ABNORMALLY HIGH PRESSURE DROP THROUGH THE SCRUBBERS IS RESTRICTING THE BOILERS TO ABOUT 80% OF THEIR CAPACITY. FAN AND DRAFT TESTS WERE BEING RUN IN DECEMBER TO PINPOINT THE PROBLEM AREA. THE FAN AND DRAFT TESTS FURTHER DELAYED SCHEDULED EMISSION TESTING. SINCE START-UP IN SEPTEMBER SCRUBBER OPERATIONS HAVE NOT BEEN SUFFICIENTLY CONSISTENT TO COMPLETE ANY EMISSION TESTS.

A TEN-INCH PLASTIC RECIRCULATION LINE BROKE ON ONE SCRUBBER AND HAD TO BE REPLACED.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CATERPILLAR TRACTOR CO.
INSTALLATION LOCATION	JOLIET, ILLINOIS
SOURCE CHARACTERISTICS	COAL (3.2% SULFUR)
SOURCE RATING	67,000 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	34 MW (EQUIVALENT); TOTAL - 2 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	ZURN INDUSTRIES
CONTROL PROCESS	DOUBLE ALKALI (DILUTE)
NEW / RETROFIT	RETROFIT
START-UP DATE	SEPTEMBER, 1974
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90+% (2000 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	NOT AVAILABLE
WATER MAKE-UP	CLOSED LOOP; 0.5 GPM
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE JOLIET PLANT OPERATES TWO COAL-FIRED BOILERS RATED AT 100,000 AND 80,000 POUNDS OF STEAM PER HOUR. THESE BOILERS ARE ON-LINE ONLY DURING WINTER MONTHS, ONE OF WHICH OPERATES 24 HR/DAY AND THE OTHER ONLY WHEN A GREATER STEAM RATE IS REQUIRED DUE TO COLD WEATHER. THE COAL HAS A HEATING VALUE OF 10,500 BTU/LB AND IS FIRED AT A RATE OF 9.65 TONS/HR. TOTAL SO2 EMISSIONS FROM THE BOLER IS 6.74 LBS/MM BTU.

THE FGD SYSTEM ON EACH BOILER IS A ZURN DOUBLE ALKALI SCRUBBER CONSTRUCTED OF 316L STAINLESS STEEL. EACH SCRUBBER EXHAUSTS THROUGH A CARBON STEEL STACK. THE TOTAL FLUE GAS FLOW RATE IS 103,500 ACFM @ 350 F. THE SCRUBBER UNITS ARE PRECEDED BY MECHANICAL COLLECTORS FOR PARTICULATE REMOVAL. THE ZURN SCRUBBER UTILIZES A DUSTRAXTOR MODULE FOR BOTH PARTICULATE AND SO2 CONTROL.

SPENT SCRUBBING LIQUOR IS PUMPED TO THE REGENERATION AREA WHERE LIME IS ADDED TO PRODUCE CALCIUM SULFITE/SULFATE IN CLARIFIERS. CLARIFIER UNDERFLOW, WHICH IS 15-20% SOLIDS BY WEIGHT, IS DEWATERED BY VACUUM FILTERS TO APPROXIMATELY 65% SOLIDS BY WEIGHT. THE THIXOTROPIC SLUDGE PRODUCED IS READY FOR DISPOSAL AT A LANDFILL. CLARIFIER OVERFLOW IS RETURNED TO THE SCRUBBER AS REGENERATED SCRUBBING LIQUOR. SODA ASH IS ALSO ADDED TO THE REGENERATED LIQUOR TO REPLENISH SODIUM LOST IN THE SLUDGE. LIME AND SODA ASH ARE STORED IN OUTSIDE SILOS AND PNEUMATICALLY CONVEYED TO USE POINTS. A CHEMICAL TREATMENT BUILDING WAS ERECTED TO HOUSE REGENERATION AND SLUDGE HANDLING EQUIPMENT.

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

CATERPILLAR TRACTOR CO.: JOLIET, ILLINOIS (CONTINUED)

REFER TO FIGURE 14-23 OF SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1977 PROBLEMS OCCURRED WHEN A TANK RAN DRY AND DAMAGED A PUMP. SOME PIPE PLUGGING PROBLEMS ALSO OCCURRED AS A RESULT OF THE PUMP FAILURE. A MAJOR PROBLEM AREA WAS THE HEAVY WEAR OF THE FILTER CLOTHS ON THE VACUUM FILTERS. THE FILTER CLOTH LASTS ONLY 2 TO 3 WEEKS. NO SOLUTIONS HAD BEEN FOUND BUT FILTER DESIGN MODIFICATIONS WERE BEING CONSIDERED. THE UNITS WERE ULTRASONICALLY TESTED AND RESULTS SHOW THAT THE SYSTEMS ARE ON THE HIGH SIDE OF TOLERANCE LEVELS. A MINOR LEAK WAS DETECTED AS A RESULT OF A FAULTY WELD.

4TH QUARTER-1977 FGD SYSTEM RESTART OCCURRED AT THE BEGINNING OF THE HEATING SEASON. PLANT HAD INITIATED A PROCESS OF DETAILED RECORD KEEPING BUT WAS STILL WORKING ON THE INTERNAL INFORMATION TRANSFER PROCESS. PLANT HAS INDICATED THAT A SUMMARY OF THESE RECORDS WILL BE AVAILABLE TO THIS REPORT IN THE FUTURE.

1ST QUARTER-1978 FILTER CLOTH PROBLEMS CONTINUED WITH REPLACEMENT BEING REQUIRED EVERY 2-3 WEEKS. THE SYSTEMS WERE DOWN IN MARCH BECAUSE OF PLUGGED PIPELINES.

2ND QUARTER-1978 UNRELIABLE SO2 MONITORS WERE A PROBLEM DURING THIS PERIOD. HEAVY ATTRITION OF FILTER CLOTHS CONTINUED.

3RD QUARTER-1978 DUE TO SHORT FILTER FABRIC LIFE AND SLUDGE FREEZE UP PROBLEMS, FILTER DESIGN MODIFICATIONS WERE STILL BEING CONSIDERED, BUT HAD NOT YET BEEN MADE.

SO2 MONITORS ARE STILL A PROBLEM EXHIBITING PLUGGING, CORROSION, AND UNRELIABLE PERFORMANCE. PROBES OF 304 SS, 316L SS AND TEFLON COATING HAVE ALL BEEN TRIED WITHOUT SUCCESS. HASTELLOY-C PROBES HAVE BEEN INSTALLED, BUT THE PLANT HAS NOT HAD TIME TO EVALUATE THEIR PERFORMANCE. REHEAT EQUIPMENT WAS SCHEDULED TO BE INSTALLED BUT HAS NOT BEEN AS OF THIS UP-DATE. GUILLOTINE-TYPE DAMPERS REPLACED THE LOUVER-TYPE ISOLATION DAMPERS ORIGINALLY INSTALLED. HOWEVER, THE GUILLOTINE-TYPE CANNOT BE CLOSED TIGHTLY BECAUSE FLY ASH COLLECTS IN THE BOTTOM OF THE GUILLOTINE SHEATH.

4TH QUARTER-1978 THE BOILERS STARTED OPERATIONS IN THE LAST WEEK OF OCTOBER. FILTER CLOTH WEAR CONTINUES TO BE A PROBLEM. THE HASTELLOY-C SO2 PROBES REQUIRE EXCESSIVE MAINTENANCE FOR PROPER FUNCTIONING. CORROSION AND EROSION OF THE PROBES IS NOT YET EVIDENT. FLYASH ACCUMULATION IN THE BOTTOM OF THE GUILLOTINE DAMPERS IS STILL A PROBLEM.

ALTHOUGH PIPE PLUGGING IS NOT NORMALLY A PROBLEM (THE ENTIRE SYSTEM IS FLUSHED AND CLEANED DURING THE SUMMER OFF SEASON), SLIGHT BUILDUPS IN THE PIPING HAVE OCCURRED.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CATERPILLAR TRACTOR CO.
INSTALLATION LOCATION	MORTON, ILLINOIS
SOURCE CHARACTERISTICS	COAL (3.2% SULFUR)
SOURCE RATING	38,000 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	19 MW (EQUIVALENT); TOTAL 2 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	ZURN INDUSTRIES
CONTROL PROCESS	DOUBLE ALKALI (DILUTE)
NEW / RETROFIT	RETROFIT
START-UP DATE	JANUARY, 1978
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90% (2000 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

AT THE MORTON PLANT, A PARTS DISTRIBUTION CENTER, CATERPILLAR TRACTOR OPERATES A TWO-BOILER STEAM PLANT WHICH GENERATES A TOTAL OF 66,000 ACFM AT 450 F AT MAXIMUM LOAD. THE STOKER COAL-FIRED BOILERS ARE MANUFACTURED BY WICKS AND ARE RATED FOR 60,000 LB/HR STEAM EACH AT 150 PSIG. AN OIL-FIRED BOILER RATED AT 120,000 LB/HR STEAM IS AVAILABLE AS BACK-UP. HEAT INPUT IS 70.7 MM BTU/HR. THE HEATING VALUE OF THE COAL IS 10,400 BTU/LB.

EMISSIONS ARE CONTROLLED BY A ZURN INDUSTRIES AIR QUALITY CONTROL SYSTEM CONSISTING OF A DUSTRAXTOR SCRUBBER IN WHICH PARTICULATE AND SO2 REMOVAL OCCUR SIMULTANEOUSLY. SULFUR DIOXIDE REMOVAL IS BROUGHT ABOUT BY THE USE OF ZURN DILUTE MODE DOUBLE ALKALI FGD TECHNOLOGY. THE TWO BOILERS AND THE TWO SCRUBBING TRAINS AND MOST ANCILLARY EQUIPMENT ARE WITHIN THE BOILER HOUSE.

THE SYSTEM AT MORTON IS VERY SIMILAR TO THAT AT THE CATERPILLAR JOLIET PLANT, WHICH HAS BEEN OPERATING EACH HEATING SEASON SINCE OCTOBER 1974. WHENEVER POSSIBLE, PROBLEM AREAS AND SOLUTIONS IDENTIFIED IN JOLIET OPERATIONS HAVE BEEN IMPLEMENTED TO IMPROVE THE SYSTEM DESIGN AT MORTON. SPECIFIC AREAS IN WHICH MODIFICATIONS TO DESIGN HAVE BEEN MADE ARE WATER BALANCE, PUMPS, PH MONITORING, PIPING, LIME STORAGE, AND COLD WEATHER PROTECTION.

REFER TO FIGURE 14-9 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

1ST QUARTER-1978   SYSTEM START-UP OCCURRED AT THE BEGINNING OF JANUARY. INITIAL OPERATIONS WERE PROBLEM-FREE. THROUGH JANUARY AND PART OF FEBRUARY, ZURN PERSONNEL WERE TRAINING THE BOILER PLANT

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

CATERPILLAR TRACTOR CO.; MORTON, ILLINOIS (CONTINUED)

PERSONNEL IN THE OPERATION OF THE FGD SYSTEM. OPERATIONAL EXPERIENCES AT JOLIET AND MOSSVILLE HAVE SHOWN THAT THE BOILER OPERATORS CAN BE EFFECTIVELY TRAINED TO OPERATE AND MAINTAIN THE FGD SYSTEMS. CURRENT PLANS CALLED FOR ACCEPTANCE TESTING IN THE SPRING, BUT THE COAL SITUATION MAY DELAY THE TEST PERIOD.

2ND QUARTER-1978 FGD OPERATIONS CONTINUED TO BE TROUBLE-FREE. THE BOILER WAS EXPERIENCING SOME PUFFING (BACK PRESSURE), THE CAUSE OF WHICH WAS NOT KNOWN.

3RD QUARTER-1978 ACCEPTANCE TESTING WAS DELAYED DUE TO THE PUFFING PROBLEM. THE TESTING WILL BE ATTEMPTED LATE THIS FALL. EVEN THOUGH PUFFING REMAINS A PROBLEM, PLANT PERSONNEL FEEL THEY ARE CLOSER TO RESOLVING IT DUE TO NEW DESIGN MODIFICATIONS TO THE SCRUBBER.

4TH QUARTER-1978 DURING THIS QUARTER, THE PUFFING PROBLEM WAS CORRECTED. THE PUFFING PROBLEM WAS A RESULT OF SEVERE PRESSURE PULSATIONS INSIDE THE ABSORBER DURING OPERATIONS. INSTANTANEOUS PRESSURE DROPS OF 10 INCHES W.G. ACROSS THE SCRUBBER OCCURRED SEVERAL TIMES. ZURN INDUSTRIES PERSONNEL TRIED TO SOLVE THE PROBLEM BY INSTALLING TURNING ELBOWS IN THE STACK, BUT THIS FAILED TO SOLVE THE PROBLEM. FINALLY PLANT PERSONNEL INSTALLED WINDOWS IN THE ABSORBER AND THROUGH THE USE OF SPOTLIGHTS OBSERVED THE ACTION OF BLOWING COLD AIR THROUGH THE ABSORBER. IT WAS NOTICED THAT A WAVE BEGAN TO PROPAGATE BACK AND FORTH ACROSS THE ABSORBER CAUSING THE WATER LEVEL AT THE BOTTOM OF THE DOWNCOMER CHANNELS TO DROP BELOW THE BOTTOM OF THE CHANNELS. GAS WAS THEN ALLOWED TO PASS UP THE DOWNCOMER CHANNELS (ONE ON EACH SIDE OF THE ABSORBER) INSTEAD OF THE NORMAL SCRUBBING TUBES AND PREVENTED THE SCRUBBING LIQUOR TO RETURN TO THE BOTTOM POOL. AS A RESULT, PULSATIONS OCCURRED ALONG THE DOWNCOMER. THE PROBLEM WAS SOLVED BY SEALING THE DOWNCOMER WITH WELDED PLATES EXCEPT FOR THREE TUBES. THESE TUBES WERE LONGER THAN THE ORIGINAL DOWNCOMER CHANNEL TO ENSURE THE TUBE BOTTOMS REMAINED CONTINUOUSLY SUBMERGED.

SINCE THE PH PROBES CONTINUOUSLY BECAME PLUGGED AND GAVE FALSE READINGS, PH IS MEASURED HOURLY WITH A MULTI-BAND LITMUS PAPER.

AN INITIAL WATER BALANCE PROBLEM WAS CAUSED BY TOO MUCH WATER ENTERING THE FGD SYSTEM AS PUMP SEAL WATER. IT WAS CORRECTED BY INSTALLING ROTAMETERS ON SEAL WATER LINES TO REGULATE FLOW.

ACCEPTANCE TESTING HAS BEEN COMPLETED AND AN APPLICATION HAS BEEN SUBMITTED TO THE STATE FOR A STATE PERMIT TO OPERATE. THE PLANT BELIEVES THEY WILL RECEIVE THE FIRST SUCH PERMIT IN ILLINOIS TO BURN HIGH SULFUR COAL IN AN INDUSTRIAL BOILER.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CATERPILLAR TRACTOR CO.
INSTALLATION LOCATION	MOSSVILLE, ILLINOIS
SOURCE CHARACTERISTICS	COAL (3.2% SULFUR)
SOURCE RATING	140,000 SCFM (TOTAL - 4 BOILERS)
NUMBER OF SEPARATE FGD UNITS	4
NUMBER OF BOILERS BEING CONTROLLED	4
SOURCE CAPACITY	70 MW (EQUIVALENT); TOTAL - 4 BOILERS
	(FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	DOUBLE ALKALI (CONCENTRATED)
NEW / RETROFIT	2 NEW 2 RETRO
START-UP DATE	OCTOBER, 1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90+% (2000 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL
	60+% SOLIDS (CASO4) SLUDGE DIRECTLY TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

AT THE MOSSVILLE PLANT, CATERPILLAR TRACTOR OPERATES A FOUR-BOILER STEAM PLANT. TWO OF THE BOILERS ARE RATED AT 150,000 LBS/HR STEAM AND TWO ARE RATED AT 80,000 LBS/HR STEAM. THE ENTIRE 4-UNIT PLANT IS ROUGHLY EQUIVALENT TO 70 MW OF ELECTRICAL GENERATING POWER. THE COAL FIRED IS HIGH-SULFUR (3.2%-4.0%) ILLINOIS COAL. THE FOURTH BOILER, AT 150,000 LBS/HR, BEGAN OPERATIONS IN JUNE 1977 AND ITS FGD SYSTEM WAS BYPASSED UNTIL OCTOBER 1977. THE TWO MOST RECENTLY INSTALLED BOILERS HAVE MECHANICAL COLLECTORS PRECEDING THE SCRUBBERS.

FMC ENVIRONMENTAL EQUIPMENT DIVISION HAS SUPPLIED AN AIR QUALITY CONTROL SYSTEM CONSISTING OF A VENTURI SCRUBBER FOR PARTICULATE CONTROL AND AN ABSORBER MODULE FOR SO2 CONTROL. FMC CONCENTRATED MODE, DOUBLE ALKALI FGD TECHNOLOGY IS BEING USED IN THE ABSORBER MODULES. THE TWO 150,000 LB/HR BOILERS HAVE MECHANICAL COLLECTORS REMOVING ABOUT 90% OF THE INLET FLYASH. THE SCRUBBING TRAINS ON THE TWO SMALLER BOILERS HAVE NO PRECEDING MECHANICAL COLLECTORS. THE POSITION OF THE VENTURI CAN BE CONTROLLED AUTOMATICALLY BY STEAM FLOW, BUT CURRENTLY IS NOT IN OPERATION.

WHILE THE FLYASH IN THE FINAL FILTER CAKE PROVIDES ADDED MECHANICAL STABILITY, THE HIGH ASH CONTENT IN THE RECIRCULATING SLURRY CAUSED SEVERE EROSION/ABRASION PROBLEMS IN EARLY OPERATIONS. THE ORIGINALLY INSTALLED WEIR-TYPE CONTROL VALVES HAVE BEEN REPLACED WITH SPOOL PIECES AND A CONSTANT VOLUME PUMPING SYSTEM. THERE WAS ALSO SIGNIFICANT WEAR IN THE VENTURI SCRUBBER BOTTOMS, WHICH WAS SOLVED BY THE INSTALLATION OF WEAR PLATES.

SEVERAL PROBLEM AREAS WERE IDENTIFIED AND DEALT WITH DURING THE TWO HEATING SEASONS PRIOR TO

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

CATERPILLAR TRACTOR CO.: MOSSVILLE, ILLINOIS (CONTINUED)

THE 1977-78 SEASON. THESE ARE LISTED BELOW.

PUMPS - THE RUBBER-LINED SLURRY PUMPS WERE OVERSIZED WHICH CAUSED HIGH PIPE VELOCITIES AND ACCELERATED WEAR ON THE PUMP LININGS. THESE PUMPS WERE REVISED TO LOWER THEIR OUTPUT. LOW SEAL WATER PRESSURE ALLOWED PROCESS LIQUOR TO GET INTO THE PUMP AND PACKING. ALL SEAL WATER IS NOW ONCE-THROUGH AND SYSTEM PRESSURES HAVE BEEN ADJUSTED TO MAINTAIN SEAL WATER PRESSURE ABOVE PROCESS LIQUID PRESSURES.

SLUDGE HANDLING - SLUDGE IS TRANSPORTED FROM THE VACUUM FILTERS TO THE LOADING AREA ON A BELT CONVEYOR. SEVERAL STRATEGIES, ALL INVOLVING SCRAPING OR PLOWING THE DEWATERED SLUDGE OFF THE BELT, RESULTED IN EXCESSIVE WEAR OF EITHER THE BELTS OR THE PLOWS. THE PRESENT APPROACH SIMPLY DUMPS THE MATERIAL OFF THE END OF THE BELT INTO BINS. THE POSITION OF THE BELT IS CHANGEABLE SO THAT EIGHT BINS CAN BE FILLED BEFORE THEY MUST BE EMPTIED. A FURTHER MODIFICATION HAS A DUAL POSITION CHUTE UNDER EACH BELT END POSITION, SO THAT A TOTAL OF 16 BINS CAN BE WORKED AT A TIME. SLUDGE BINS ARE THEN LOADED HYDRAULICALLY INTO TRUCKS AND HAULED TO THE SANITARY LANDFILL AREA. ANOTHER PROBLEM, COLD WEATHER ICING ON THE SLUDGE LOADING AREA, WAS SOLVED BY ENCLOSING THE AREA.

INSTRUMENTATION - ORIGINAL DESIGN PLANS CALLED FOR CONTROL BY THE MONITORING OF THE SO3/SO4 RATIO AND SODIUM ION CONCENTRATION. THE CONTROL RANGE WAS FOUND TO BE TOO SMALL AND THE PRESENT APPROACH IS PH CONTROL (6.5) AND CLEANING OF THE PROBES EVERY OTHER DAY.

ORIGINAL DESIGN DID NOT MONITOR SO2 CONCENTRATION BUT A COMPLETE MONITOR SYSTEM WAS INSTALLED PRIOR TO THE 1977-78 SEASON.

PIPING - MODIFICATIONS HAVE BEEN MADE WHICH FACILITATE CLEANING OR SCHEDULED REPLACEMENT.

REFER TO FIGURE 14-10 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

4TH QUARTER-1977 CATERPILLAR BEGAN A PROCEDURE OF DETAILED RECORD KEEPING, BUT THE INFORMATION WAS NOT YET AVAILABLE TO THIS REPORT.

2ND QUARTER-1978 NUMEROUS BOILER-RELATED PROBLEMS HAVE COMPOUNDED FGD SYSTEM PROBLEMS. MAJOR FGD PROBLEM AREAS WERE AS FOLLOWS:

EROSION OF SCRUBBER LINER MATERIAL.
EXCESSIVE WEAR OF PIPING, PUMPS, AND CONTROL VALVES.
SLUDGE FREEZE-UP ON THE CONVEYOR BELT PLUGGED SLUDGE CHUTES.

3RD QUARTER-1978 PERFORMANCE OF THE VENTURI SPRAY NOZZLES HAS NOT BEEN SATISFACTORY. NOZZELS OF 316L SS WERE ORIGINALLY INSTALLED AND LASTED ABOUT FOUR MONTHS. CERAMIC NOZZLES WERE THEN TRIED BUT BROKE WHEN BEING REMOVED. THE PLANT RETURNED TO USING 316L SS SINCE THE STEEL NOZZLES WERE CHEAPER THAN THE CERAMIC NOZZLES. PLANS ARE BEING MADE TO MODIFY THE NOZZLE CONFIGURATION. THE VENTURI IS BEING OPERATED MANUALLY SINCE PLANT PERSONNEL HAVE NOT HAD TIME TO DEBUG THE AUTOMATIC CONTROL.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

CATERPILLAR TRACTOR CO.; MOSSVILLE, ILLINOIS (CONTINUED)

END-DISCHARGING DISH CONVEYORS FOR THE SLUDGE CONVEYOR SYSTEM HAVE NOT YET BEEN INSTALLED BECAUSE THE ENTIRE SLUDGE HANDLING FACILITY IS CURRENTLY BEING REEVALUATED. THIS REEVALUATION IS A RESULT OF THE MANY PROBLEMS CATERPILLAR HAS HAD WITH THEIR SLUDGE HANDLING SYSTEM.

MODIFICATIONS TO PIPING IN ORDER TO FACILITATE PIPE CLEANING AND SCHEDULED REPLACEMENTS HAVE NOT BEEN SIGNIFICANT. THE GUILLOTINE DAMPERS AT THIS PLANT ARE EXPERIENCING THE SAME PROBLEMS AS THE DAMPERS AT THE JOLIET PLANT: FLYASH COLLECTING IN THE BOTTOM OF THE DAMPER PREVENTS THE DAMPER FROM BEING CLOSED TIGHTLY. WEAR PLATES WERE INSTALLED IN THE BOTTOM OF THE VENTURI SCRUBBERS TO PREVENT ABRASIVE WEAR AND ARE WORKING WELL. PLANT PERSONNEL FEEL THEY ARE STILL IN A DEBUGGING PHASE.

4TH QUARTER-1978 PLANT PERSONNEL DESCRIBED THE FGD SYSTEM OPERATION AS SPORADIC AND FLUCTUATING. PROBLEMS ARE ENCOUNTERED, CONTINUOUSLY CAUSING SYSTEM SHUTDOWN. EROSION CONTINUES TO BE A SIGNIFICANT PROBLEM. VALVES, FITTINGS, LININGS, PUMPS, FANS, AND SCRUBBER NOZZLES ARE ALL ERODING. THE WEAR PLATE INSTALLED IN THE BOTTOM OF THE SCRUBBER HAS SLOWED THE EROSION THERE.

THE VENTURI NOZZLE CONFIGURATION WAS NOT CHANGED AND THE VENTURI IS STILL OPERATED MANUALLY.

THE SLUDGE HANDLING FACILITIES HAVE NOT BEEN REEVALUATED OR CHANGED YET. FILTER FABRIC WEAR AND SLUDGE FREEZE-UP CONTINUE TO BE A PROBLEM.

A MAINTENANCE PROGRAM TO CLEAN THE GUILLOTINE DAMPER OF FLYASH HAS NOT YET BEEN DEVELOPED.

AN EMISSIONS TEST IS SCHEDULED FOR LATE JANUARY OR EARLY FEBRUARY 1979.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CHEVRON U.S.A. INC.
INSTALLATION LOCATION	BAKERSFIELD, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.1% SULFUR)
SOURCE RATING	248,000 SCFM (TOTAL - 18 BOILERS) 150,000 ACFM @ 500F, FOR EACH OF 3 FGD SYSTEMS.
NUMBER OF SEPARATE FGD UNITS	3
NUMBER OF BOILERS BEING CONTROLLED	18
SOURCE CAPACITY	125 MW (EQUIVALENT); TOTAL - 18 BOILERS 900 MM BTU/HR (TOTAL - 18 BOILERS; 6 BOILERS/FGD SYSTEM) (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	KOCH ENGINEERING
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	JULY, 1978
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90% (70 PPM @ OUTLET)
WATER MAKE-UP	12 - 13 GPM
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO TAILINGS POND
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

CHEVRON U.S.A. HAS AN OIL SITE AT BAKERSFIELD, CALIFORNIA. THERE ARE ABOUT 50 STEAM GENERATORS WHICH BURN 1.1% SULFUR CRUDE OIL. EACH GENERATOR IS RATED AT 50 MM BTU/HR. THE STEAM IS USED FOR ENHANCED OIL RECOVERY FROM THE OIL WELLS.

KOCH ENGINEERING COMMISSIONED THREE FGD SYSTEMS IN JUNE/JULY 1978. THE SODIUM CARBONATE SCRUBBING PROCESS IS USED. EACH SCRUBBER TREATS FLUE GASES FROM 6 GENERATORS WITH A TOTAL FLOW RATE OF 150,000 ACFM AT 500 F. THE GAS IS QUENCHED IN THE BOTTOM PORTION OF THE ABSORBER BY 120 GPM OF THE RECIRCULATING LIQUOR. THERE ARE 3 KOCH FLEXITRAYS AND A KOCH FLEXIMESH MIST ELIMINATOR IN EACH SCRUBBER. THE SPENT LIQUOR IS MIXED WITH FRESH SODIUM CARBONATE SOLUTION IN THE BOTTOM OF THE SCRUBBER. A CONTINUOUS BLEED-OFF STREAM (1-2 GPM) IS TAKEN TO A DISPOSAL POND, WHEREAS THE REST OF THE LIQUOR IS RECIRCULATED AT A TOTAL RATE OF 900 GPM (15 WT% DISSOLVED SOLIDS). A PH OF 6.5 IS MAINTAINED AT THE TOP TRAY AND AN L/G RATIO OF 8 GAL/1000 ACF IS USED. THERE IS NO REHEAT FACILITY BUT THE SCRUBBER CAN BE BYPASSED. THE BOILER I.D. FANS WERE UPGRADED FROM 50 HP TO 75 HP TO OFFSET THE PRESSURE DROP OF 9 IN. WG. ACROSS THE ABSORBER. THE SCRUBBERS ARE DESIGNED TO REMOVE 90% OF THE SO2 AND MAINTAIN AN EXIT SO2 CONCENTRATION BELOW 70 PPM. EACH SCRUBBER IS 16.5 FT IN DIAMETER AND 35 FEET HIGH. THE STUB STACK SITUATED ON TOP OF EACH SCRUBBER IS ABOUT 20 FEET HIGH AND 8 FEET IN DIAMETER. THE SCRUBBERS AND TRAYS ARE MADE OF 316L SS AND THE

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

CHEVRON U.S.A. INC.: BAKERSFIELD, CALIFORNIA (CONTINUED)

FLEXIMESH IS INCOLOY 825. THE STACK IS MADE OF 316 SS AND THE PIPING IS FRP.

REFER TO FIGURE 14-12 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1978 BECAUSE OF LOW STEAM DEMAND ONLY TWO OF THE EXISTING THREE SCRUBBERS ARE OPERATIONAL (OUT OF THE 18 STEAM GENERATORS 12 ARE OPERATIONAL). ONE SCRUBBER CONTROLS 7 GENERATORS WHILE THE OTHER CONTROLS 5 GENERATORS. THE REMAINING 6 STEAM GENERATORS AND THE CORRESPONDING SCRUBBER WILL BE BROUGHT ON-LINE AS STEAM DEMAND INCREASES (POSSIBLY IN DECEMBER OR JANUARY).

NO MAJOR PROBLEMS HAVE OCCURRED SINCE START-UP IN JUNE-JULY 1978. HOWEVER, SOME CLOGGING OF THE SODA ASH FEED CHUTE FROM THE STORAGE SILO DOES OCCUR. THIS CLOGGING IS EASILY CORRECTED WITH NO DOWNTIME NECESSARY. SYSTEM OPERABILITY FOR THE PERIOD WAS 95%.

GOOD OPERATION IS ATTRIBUTED TO REGULAR MAINTENANCE PRACTICE WITH EMPHASIS ON DAILY CLEANING OF THE PH PROBES.

4TH QUARTER-1978 SYSTEM AVAILABILITY OF 100% WAS REPORTED FOR THIS PERIOD. THERE WERE NO SCALING OR PLUGGING PROBLEMS. ROTATING EQUIPMENT (FANS, PUMPS) HAVE OPERATED WITHOUT TROUBLE. THE MIST ELIMINATOR WASH FREQUENCY IS TWICE A DAY, ABOUT 20 MINUTES AT A TIME, APPROXIMATELY 50 GPM FLOW OF FRESH WATER.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	FIRESTONE TIRE AND RUBBER CO.
INSTALLATION LOCATION	POTTSTOWN, PENNSYLVANIA
SOURCE CHARACTERISTICS	COAL (2.5 - 3.0% SULFUR)
SOURCE RATING	8070 SCFM (13,000 ACFM @ 300 F)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	4 MW (EQUIVALENT) (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	DOUBLE ALKALI (CONCENTRATED)
NEW / RETROFIT	RETROFIT
START-UP DATE	JANUARY, 1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90.5% (1000 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	97.4% (5 LB/MM BTU @ INLET TO MECHANICAL COLLECTOR.)
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE FIRESTONE TIRE AND RUBBER CO. LOCATED IN POTTSTOWN, PENNSYLVANIA HAS BEEN OPERATING AN FGD SYSTEM SINCE JANUARY 1975 AS A DEMONSTRATION-SIZE PLANT, DESIGNED TO TEST THE FEASIBILITY OF FGD ON INDUSTRIAL BOILERS. THE UNIT IS DEMONSTRATING 90 PERCENT SO2 REMOVAL EFFICIENCY AND TREATS A FLUE GAS CAPACITY OF 13,000 ACFM OR 3 MW (EQUIVALENT). THIS FLOW REPRESENTS APPROXIMATELY 1/3 OF THE TOTAL OUTPUT OF ONE 120,000 LB/HR STEAM BOILER. THE SULFUR DIOXIDE EMISSION REGULATION FOR THE PLANT IS 0.86 LBS/MILLION BTU OF HEAT INPUT.

THE PLANT IS USING THE CONCENTRATED DOUBLE ALKALI PROCESS PATENTED BY FMC CORPORATION. THE LOAD CAPACITY OF THE BOILER ON WHICH THE SCRUBBER IS OPERATING IS APPROXIMATELY 15 MW. IN OCTOBER 1976, THE BOILER WAS CONVERTED FROM BURNING RESIDUAL FUEL OIL (2.2% S) TO COAL (2.5-3.0% S).

THE VENTURI SCRUBBER IS SPRAYED WITH ALKALINE LIQUOR WHERE THE FLUE GAS ENTERS. THE FAN AND DAMPER UPSTREAM OF THE VENTURI CONTROL THE FLUE GAS FEED. SCRUBBING LIQUOR FLOWS FROM THE VENTURI TO THE BOTTOM OF THE CYCLONE DEMISTER AND THEN INTO THE RECIRCULATION TANK. DROPLETS OF SCRUBBING LIQUOR ARE SPUN OUT IN THE CYCLONE AND RUN BACK DOWN INTO THE RECIRCULATION TANK. THE SCRUBBING LIQUOR IS PARTLY RECIRCULATED TO THE VENTURI THUS COMPLETING THE SCRUBBING CYCLE. ACCUMULATION OF SOLUBLE SODIUM BISULFITE IS PREVENTED BY CONTINUOUSLY DRAWING OFF A SMALL STREAM OF SCRUBBER SOLUTION TO THE LIME REACTOR TANK WHERE THE SODIUM SULFITE REACTS WITH LIME TO FORM CALCIUM SULFITE AND SODIUM HYDROXIDE WHICH IS RECYCLED TO THE ABSORBER. CALCIUM SULFITE SLURRY IS TRANSFERRED TO THE ROTARY FILTER. THE FILTER CAKE FORMED (180 LBS/HR, 55% SOLIDS) IS HAULED TO THE LANDFILL. THE

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

FIRESTONE TIRE AND RUBBER CO. : POTTSTOWN, PENNSYLVANIA (CONTINUED)

WATER BALANCE IS MAINTAINED BY MAKING UP FOR THE LOSSES BY EVAPORATION AND IN THE FILTER CAKE.

THE VENTURI SCRUBBER HAS A VARIABLE THROAT (6 IN. TO 15 IN.) AND IS MADE OF 316L SS. THE OPERATING VELOCITY THROUGH THE VENTURI THROAT IS 200 FT/SEC @ 130 F. THE OPERATING L/G IS 10 GAL/1000 ACF. THE SPRAY NOZZLES ARE ALSO MADE OF 316L SS. THE CYCLONIC DEMISTER (4.67 FT DIA X 7.17 FT HIGH) OPERATES WITH A PRESSURE DROP OF 2" WG. GAS VELOCITY THROUGH THE DEMISTER IS 100 FT/SEC @ 130 F. THE DEMISTER, RECIRCULATION TANK, AGITATOR, RECIRCULATION PIPING, AND THE FILTER ARE MADE OF 316L SS. THE INLET DUCTWORK, F.D. FAN, THICKENER, AND LIME REACTOR TANK ARE OF CARBON STEEL. THE RECIRCULATION PUMP IS CAST IRON WITH RUBBER LINING AND THE STACK IS FRP.

REFER TO FIGURE 14-13 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

1ST QUARTER-1975 THE SYSTEM WENT ONSTREAM BURNING 2.2% SULFUR OIL. THE FGD SYSTEM OPERATED 687 HOURS AND WAS CALLED UPON TO OPERATE 819 HOURS, YIELDING A RELIABILITY OF 84.5%. DOWNTIME WAS DUE PRIMARILY TO FAILURES OF COMPONENTS SUCH AS PUMP PACKING.

2ND QUARTER-1975 THE SYSTEM OPERATED 1454 HOURS AND WAS CALLED UPON TO OPERATE 1509 HOURS, YIELDING A RELIABILITY INDEX VALUE OF 96.4%.

3RD QUARTER-1975 SYSTEM OPERATED 1436 HOURS, WAS CALLED UPON TO OPERATE 1503 HOURS, YIELDING A RELIABILITY INDEX VALUE OF 95.5%.

4TH QUARTER-1975 SYSTEM OPERATED 1320 HOURS, WAS REQUIRED TO OPERATE 1493 HOURS, YIELDING A RELIABILITY INDEX VALUE OF 88.4%. LIME FEEDER MALFUNCTIONING AND THICKENER PLUGGING WERE PROBLEMS.

1ST QUARTER-1976 SYSTEM OPERATED 1961 HOURS, WAS CALLED ON TO OPERATE 2035 HOURS, YIELDING A RELIABILITY INDEX VALUE OF 96.4%.

2ND QUARTER-1976 SYSTEM OPERATED 1280 HOURS, WAS CALLED UPON TO OPERATE 1335 HOURS, YIELDING A RELIABILITY INDEX VALUE OF 95.9%.

3RD QUARTER-1976 SYSTEM OPERATED 1157 HOURS, WAS CALLED UPON TO OPERATE 1166 HOURS, THUS DEMONSTRATING ITS HIGHEST RELIABILITY INDEX VALUE, 99.2%.

4TH QUARTER-1976 IN OCTOBER, THE SYSTEM OPERATED AT A RELIABILITY INDEX OF 100%, UNTIL THE UNIT WAS CONVERTED TO COAL FIRING (2.5 - 3.0% SULFUR). THE SYSTEM OPERATED FOR AN ADDITIONAL 511 HOURS, OF THE 526 REQUIRED, DEMONSTRATING A RELIABILITY INDEX VALUE OF 97.2%. IN NOVEMBER AND DECEMBER,

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

FIRESTONE TIRE AND RUBBER CO. ; POTTSTOWN, PENNSYLVANIA (CONTINUED)

THE SYSTEM OPERATED FOR 1172 HOURS AGAINST THE REQUIREMENT OF 1211 HOURS. THEREFORE, THE AVERAGE RELIABILITY INDEX FOR THE TWO MONTHS WAS 96.7%.

1ST QUARTER-1977 SYSTEM OPERATED 1193 HOURS, WAS REQUIRED TO OPERATE FOR 1459 HOURS, YIELDING A RELIABILITY INDEX VALUE OF 81.7%. SYSTEM WAS DESIGNED FOR A MUCH LOWER PARTICULATE LOADING THAN THAT ACTUALLY ENCOUNTERED ON COAL FIRING. THE HIGH GRAIN LOADING CAUSED ABNORMAL WEAR AND DOWNTIME OF THE F.D. FAN.

2ND QUARTER-1977 SYSTEM OPERATED 1398 HOURS, WAS REQUIRED TO OPERATE 1690 HOURS, YIELDING A RELIABILITY INDEX VALUE OF 82.7%. THE MAJOR CAUSES OF DOWNTIME WERE F.D. FAN EROSION AND PUMP COMPONENT FAILURES.

3RD QUARTER-1977 SYSTEM OPERATED 1131 HOURS, WAS REQUIRED TO OPERATE 1197 HOURS, YIELDING A RELIABILITY FIGURE OF 94.5%. THE TOTAL REQUIRED HOURS WERE LOW IN JULY DUE TO BOILER HOUSE SHUTDOWN AND SUBSEQUENT START-UP.

4TH QUARTER-1977 IN OCTOBER, THE SYSTEM OPERATED 432 HOURS OUT OF THE 511 REQUIRED AS THE BOILER WAS FIRING COAL. THE RELIABILITY VALUE WAS THEREFORE 84.6%. DOWNTIME WAS CAUSED BY PROBLEMS WITH THE LIME CONVEYOR. WHEN OIL WAS BEING FIRED THE SYSTEM OPERATED 95 OF THE 102 HOURS REQUIRED, DEMONSTRATING A RELIABILITY VALUE OF 92.6%. IN NOVEMBER AND DECEMBER, THE SYSTEM OPERATED 792 HOURS OF THE REQUIRED 854, WHILE BURNING COAL, YIELDING A RELIABILITY OF 86.7%. DOWNTIME WAS CAUSED BY FAN PROBLEMS AND LIME FEEDER PROBLEMS.

1ST QUARTER-1978 THE SPRAY NOZZLES, ORIGINALLY 316 STAINLESS STEEL, WERE REPLACED BY 316L SS. THE SPRAY BARS WERE METALLIZED WITH 316 SS.

2ND QUARTER-1978 THE FAN WAS REPLACED BY A NEW FAN CONSTRUCTED OF AN ABRASION RESISTANT CARBON STEEL. THE FAN HOUSING WAS METALLIZED WITH 316 SS. LEAKS IN THE VENTURI SECTION AND DOWNSTREAM DUCTWORK WERE REPAIRED. THE FGD SYSTEM EXHIBITED AN AVAILABILITY OF 89.5% FOR THIS REPORT PERIOD.

3RD QUARTER-1978 NO UNUSUAL PROBLEMS WERE ENCOUNTERED DURING THIS PERIOD. DOWNTIME WAS DUE TO NORMAL MAINTENANCE. PRELIMINARY ENGINEERING FOR THE FULL SCALE-UP SYSTEM IS COMPLETE. FINAL DESIGN WILL BE DELAYED UNTIL THE ENERGY BILL CURRENTLY BEFORE CONGRESS IS FINALIZED. PLANT PERSONNEL ATTRIBUTE THEIR SUCCESSFUL OPERATION OF THE FGD SYSTEM TO A GOOD UNDERSTANDING AND IN-DEPTH KNOWLEDGE OF PROCESSES AND CONTROLS.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

FIRESTONE TIRE AND RUBBER CO. ; POTTSTOWN, PENNSYLVANIA (CONTINUED)

4TH QUARTER-1978   IN OCTOBER, THE BOILER WAS DOWN FOR MAINTENANCE, HENCE THE SCRUBBER DID NOT OPERATE. DURING NOVEMBER AND DECEMBER, THE SYSTEM OPERATED 311 HOURS OF A REQUIRED 332 HOURS, WHILE BURNING COAL, YIELDING A RELIABILITY OF 93.7%. DOWNTIME OF 20 HOURS WAS CAUSED BY BREAKAGE OF BELT ON RECIRCULATION PUMP WHICH WAS THEN REPLACED. SCHEDULED MAINTENANCE REQUIRED AN ADDITIONAL HOUR OF DOWNTIME.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	FMC (SODA ASH PLANT)
INSTALLATION LOCATION	GREEN RIVER, WYOMING
SOURCE CHARACTERISTICS	COAL (1% SULFUR)
SOURCE RATING	446,000 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	223 MW (EQUIVALENT); TOTAL - 2 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	MAY, 1976
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	95% (800 PPM AT INLET)
PARTICULATE REMOVAL EFFICIENCY	REMOVED BY PRECEDING ESP (99.5%)
WATER MAKE-UP	OPEN LOOP; L/G = 15-20 GAL/1000 ACF
SLUDGE OR BY-PRODUCT DISPOSAL	HOLDING POND FOR EVAPORATION NA2SO3/SO4 LIQUOR DISPOSED TO COLLECTION POND - NO PRIOR AERATION. LANDFILL IN THE FUTURE
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

FMC CHEMICAL CORP. HAS A SODA ASH PLANT IN GREEN RIVER, WYOMING. THE PLANT HAS TWO COAL-FIRED POWER BOILERS WHICH BURN 1.0 PERCENT SULFUR COAL. THE FLUE GAS FROM EACH BOILER (330,000 ACFM AT 320 F) IS TREATED BY A HOTSIDE ESP WITH 288 PLATES AND A PARTICULATE REMOVAL EFFICIENCY OF 99.5 %.

THE FLUE GASES ARE SCRUBBED BY THE PLANT END-LIQUOR IN TWO SCRUBBERS, EACH WITH THREE PAIRS OF DISC-AND-DONUT TRAYS. THE SCRUBBERS AND THE DISCS ARE LINED WITH CEILCOTE 103 WHEREAS THE DONUT PARTS OF THE TRAYS ARE MADE FROM INCONEL 825. THE SCRUBBER LIQUOR IS MAINTAINED AT A PH OF 6.5 AND IS RECIRCULATED AT A RATE OF 15 - 20 GALLONS/1000 ACF OF FLUE GAS. A PART OF THE RECIRCULATING LIQUOR IS CONTINUOUSLY PURGED TO REMOVE SULFITES AND SULFATES FORMED BY THE REACTION OF SO2 WITH SODA ASH. THE RECIRCULATING PUMPS AND THE RELATED PIPING IS RUBBER LINED. A MESH-TYPE DEMISTER IS USED IN EACH SCRUBBER. THE GASES ARE REHEATED BY DIRECT FIRING OF NATURAL GAS AT THE EXIT OF THE SCRUBBERS. THE REHEATED FLUE GAS IS MIXED WITH BYPASSED GAS BEFORE GOING TO THE STACK AT ABOUT 180 F. DAMPERS WITH REMOTE CONTROLS REGULATE THE FLOW OF OFFGAS THROUGH AND AROUND THE SCRUBBERS. APPROXIMATELY 50% OF THE TOTAL FLUE GAS IS RUN THROUGH THE SCRUBBERS.

AUTOMATIC CONTROLS MAINTAIN SOLUTION LEVEL IN THE SCRUBBER BASIN. THE PRIMARY SOURCE OF WATER MAKE-UP IS PROCESS WASTEWATER WHICH IS CHANNELED TO A MAKE-UP TANK. IF MORE MAKE-UP IS REQUIRED,

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

FMC (SODA ASH PLANT); GREEN RIVER, WYOMING (CONTINUED)

RIVER WATER IS TAPPED. THE SCRUBBER BLEED STREAM IS DISCHARGED TO A WASTE POND AT A RATE OF 200-250 GPM AT THE SITE.

REFER TO FIGURE 14-14 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1977 SOME PROBLEMS OCCURRED WITH THE SCRUBBER LINING AS A RESULT OF FAULTY INSTALLATION. THE POSSIBILITY OF RUNNING THE SYSTEM WITH NO REHEAT WAS BEING INVESTIGATED.

4TH QUARTER-1977 THE SCRUBBERS CORRODED AS A RESULT OF FAULTY INSTALLATION OF THE LINING. THE IMPURITIES IN THE SCRUBBING LIQUOR CAUSE FOAMING AND SEDIMENTATION ON THE TRAYS.

1ST QUARTER-1978 PIPELINE FREEZUPS, AND LEAKS FROM THE VANE DAMPERS WERE THE MAIN PROBLEM AREAS.

2ND QUARTER-1978 THE DEMISTER WAS PLUGGED, AND THE RECIRCULATION PUMP WAS DOWN FOR SOME PERIOD. PH CONTROL IS NOT VERY EFFECTIVE, CAUSING PH EXCURSIONS TO ABOUT 3.0. THIS HAS CAUSED SCALING IN THE PIPELINES AND IN THE TOWER. FMC TESTS HAVE MEASURED SO2 REMOVAL EFFICIENCY IN THE RANGE OF 87%-94%, DEPENDING ON L/G AND PH.

3RD QUARTER-1978 TWO ANNUAL SCHEDULED OUTAGES OCCURRED DURING THIS PERIOD. ONE LASTED 2 WEEKS IN AUGUST WHILE THE OTHER LASTED 1 WEEK IN SEPTEMBER. MAINTENANCE ON THE FGD SYSTEM DURING THESE OUTAGES INCLUDED CLEANING OF THE SYSTEM AND FREEING OF THE DAMPER. THE DAMPERS HAD A PROBLEM OPERATING PROPERLY DURING COLD WEATHER. IT WAS DETERMINED THAT THE PUMP OUTAGE DURING THE 2ND QUARTER WAS CAUSED BY A BROKEN SHAFT. THE SHAFT WAS REPLACED.

4TH QUARTER-1978 DURING THE REPORT PERIOD, NO MAJOR OPERATING PROBLEMS OCCURRED. ORIGINAL LINING WAS REINSTALLED ON THE RECIRCULATION PUMP WHILE USING A SPARE PUMP. THE BEARINGS OF THE SHAFT ON THE LOUVER DAMPER WERE ADJUSTED FOR FREE OPERATION OF THE DAMPERS. NO SCALING PROBLEMS HAVE BEEN REPORTED. THE RELIABILITY VALUE OF THE FGD SYSTEM WAS CLOSE TO 100%.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GENERAL MOTORS CORPORATION
INSTALLATION LOCATION	DAYTON, OHIO
SOURCE CHARACTERISTICS	COAL(0.7% - 2.6% SULFUR)
SOURCE RATING	36,000 SCFM (TOTAL - 2 BOILERS) 34,000 ACFM @ 500F, FOR EACH OF TWO BOILERS. 120,000 LB/HR STEAM (TOTAL)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	18 MW (EQUIVALENT): TOTAL - 2 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	ENTOLETER, INC.
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	SEPTEMBER, 1974
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	86% (1.43 LB/MM BTU @ INLET)
PARTICULATE REMOVAL EFFICIENCY	97.5% (0.107 LB/MM BTU @ OUTLET)
WATER MAKE-UP	50 GPM
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO CITY SEWER NA2SO3/SO4 LIQUOR AT 35 GPM TO ON-SITE CLARIFICATION AND DEWATERING FACILITY
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

IN DAYTON, OHIO, GENERAL MOTORS OPERATES A FACTORY WHICH MANUFACTURES BRAKES AND OTHER PARTS FOR THEIR AUTOMOBILES. THE PLANT HAS TWO STOKER-FEED, COAL-FIRED BOILERS WHICH WERE INSTALLED IN 1954 BY BABCOCK AND WILCOX. EACH BOILER IS RATED AT 60,000 LB/HR STEAM, AND BURNS A MAXIMUM OF 3 TONS OF COAL PER HOUR. THE BOILERS ARE EQUIPPED WITH INTERNAL MULTICLONES FOR PRIMARY PARTICULATE CONTROL. THE STEAM GENERATED BY THESE BOILERS IS USED FOR BUILDING HEAT AND PROCESS NEEDS. ONE BOILER IS OPERATED CONTINUOUSLY THROUGHOUT THE YEAR AND THE OTHER IS OPERATED APPROXIMATELY 6 MONTHS PER YEAR. THE MAJORITY OF THE TIME (8 - 10 MONTHS/YR) ONLY ONE BOILER IS IN SERVICE.

THE EMISSION CONTROL SYSTEM WAS DESIGNED TO CONTROL BOTH FLYASH AND SO2, AND WAS SUPPLIED AS A RETROFIT APPLICATION BY ENTOLETER, INC. IN SEPTEMBER 1974. EACH BOILER IS FOLLOWED BY A BOILER I.D. FAN, A PLENUM, AND A SCRUBBER F.D. FAN. THE PLENUM CAN FUNCTION IN ONE OF THREE WAYS: IT CAN FEED FLUE GASES TO THE SCRUBBER MODULE; IT CAN BYPASS THE GASES TO THE ATMOSPHERE IN CASE OF A SCRUBBER MALFUNCTION; OR IT CAN MIX AMBIENT AIR WITH THE FLUE GASES IN CASE OF LOW LOAD IN ORDER TO MAINTAIN CONSTANT AIR FLOW TO THE SCRUBBER FAN.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GENERAL MOTORS CORPORATION; DAYTON, OHIO (CONTINUED)

THE SCRUBBER CONSISTS OF THE ENTOLETER "VANE-CAGE" (5 FT. DIA. X 5 FT. HIGH) WHICH IS HOUSED IN A CONICAL BOTTOM SECTION (8 FT. DIA. X 5 FT. HIGH), AN INTERMEDIATE SECTION (6 FT. DIA. X 5 FT. HIGH), AND A DISENGAGEMENT ZONE (10 FT. DIA. X 12 FT. HIGH). THE FLUE GAS (34,000 ACFM @ 500F) ENTERS THE BOTTOM SECTION TANGENTIALLY. RECIRCULATING LIQUOR IS SPRAYED FROM THE TOP OF THE VANE CAGE SECTION, WHICH CAN BE MOVED VERTICALLY TO VARY THE PRESSURE DROP ACROSS THE SCRUBBER. A PRIMARY DEMISTER IS LOCATED ABOVE THE PREVIOUSLY MENTIONED INTERMEDIATE SECTION AND A SECONDARY DEMISTER IS LOCATED ATOP THE DISENGAGEMENT ZONE. THE GAS THEN PASSES THROUGH A STUB STACK TO THE ATMOSPHERE. SCRUBBING LIQUOR IMPINGES ON THE BOTTOM OF THE VANE CAGE AND A SPRAY CHAMBER EFFECT PROVIDES THE SO2 REMOVAL. SCRUBBER UNDERFLOW, CONTAINING PARTICULATE AND A NA2SO3/SO4 SOLUTION IS SENT TO THE RECYCLE TANK, WHERE MAKEUP WATER AT A RATE OF 50 GPM IS ADDED. RECYCLE PUMPS TAKE LIQUOR FROM THE RECYCLE TANK TOP, ALONG WITH THE CAUSTIC STREAM ADDED AT A RATE OF 14 GALLONS PER HOUR TO THE FEED LINE, AND RECIRCULATE IT TO THE TOP OF THE VANE CAGE AT A RATE OF 200 GPM. THE L/G RATIO IS 6 GAL/1000 ACF, AND A TYPICAL PRESSURE DROP ACROSS THE SCRUBBER IS 7 IN. WG. A BLEED OFF FROM THE RECIRCULATION LINE (50 GPM) IS PURGED TO A WASTEWATER TREATMENT FACILITY, WHICH CLARIFIES ALL THE PLANT WASTE STREAMS, ADJUSTS THE PH (7-9), AND DISCHARGES TO CITY SEWERS.

ABSORBER MODULES, DEMISTERS, STACKS, AND THE RECYCLE TANK ARE CONSTRUCTED OF 316L STAINLESS STEEL. THE SCRUBBER F.D. FANS, PLENUMS, CAUSTIC TANK, CAUSTIC PUMP, AND INLET DUCTWORK ARE ALL CARBON STEEL. THE RECIRCULATION PUMPS AND PIPING ARE RUBBER-LINED.

THE TOTAL INSTALLED COST OF THE SYSTEM WAS $668,000 IN 1974 DOLLARS. THE AVERAGE OUTLET SO2 CONCENTRATION IS 0.21 LB/MM BTU, WELL UNDER THE REGULATION OF 1.0 LB/MM BTU. THE OUTLET PARTICULATE LOADING IS 0.107 LB/MM BTU AND THE REGULATION IS 0.177 LB/MM BTU.

REFER TO FIGURE 14-15 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

4TH QUARTER-1974   UPON START-UP, SEVERAL PROBLEMS WERE ENCOUNTERED. PARTICULATE BUILDUP CAUSED PLUGGING OF THE RECYCLE TANK DRAIN AND WASTE STREAM SUMP PUMPS. AIR PURGE STREAMS WERE INSTALLED TO ALLEVIATE THESE PROBLEMS.

1ST QUARTER-1975   THE DAMPERS AND DAMPER CONTROL SYSTEMS WERE MAJOR PROBLEMS. THREE SETS OF EXPANSION JOINTS HAD TO BE INSTALLED BEFORE ACHIEVING PROPER FLOW CONTROL.

2ND QUARTER-1975   A FAN BEARING HAD TO BE REPLACED THREE TIMES.

3RD QUARTER-1975   INSTRUMENTATION AND CONTROL PROBLEMS PROMPTED WIRING REVISIONS.

4TH QUARTER-1976   THE FGD SYSTEM DEMONSTRATED AN AVAILABILITY OF 93 PERCENT.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GENERAL MOTORS CORPORATION; DAYTON, OHIO (CONTINUED)

1ST QUARTER-1977 THERE WERE MECHANICAL PROBLEMS WITH THE VANE CAGE DRIVE. THE ACCESS DOOR DEVELOPED LEAKS AND THE LIQUOR CORRODED THE OUTER SURFACE OF THE INLET DUCT AROUND THE ACCESS DOOR.

4TH QUARTER-1977 CORROSION AND PLUGGING PROBLEMS CONTINUED TO HAMPER SCRUBBER OPERATIONS. HOWEVER, USUALLY WHEN A SCRUBBER IS DOWN, THE OTHER BOILER IS FIRED UP WHILE REPAIRS ARE MADE TO THE DOWNED UNIT.

1ST QUARTER-1978 THE PRIMARY DEMISTER WAS SEVERELY CORRODED DUE TO ACID DROPPING DOWN ONTO IT FROM THE UPPER DEMISTER.

2ND QUARTER-1978 THE FOLLOWING SYSTEM MODIFICATIONS WERE BEING PLANNED: THE INTERMEDIATE SECTION WILL BE REMOVED, THE PRIMARY DEMISTER WILL BE REPLACED BY A SIMILAR VANE-TYPE HASTELLOY-G DEMISTER, THE SECONDARY DEMISTER WILL BE REPLACED BY A RADIAL VANE HASTELLOY-G DEMISTER, AND A CONVEX IMPINGEMENT BAFFLE PLATE OF HASTELLOY-G WILL BE INSTALLED ABOVE THE PRIMARY DEMISTER TO ASSIST IN RAPID DRAINAGE OF THE ACID DROPLETS.

3RD QUARTER-1978 THE MODIFICATIONS DESCRIBED IN THE 2ND QUARTER 1978 ARE STILL IN THE DESIGN PROCESS. WORK INCORPORATING THE MODIFICATIONS SHOULD BEGIN ABOUT THE END OF OCTOBER.

THE SCRUBBER LINING OF COAL TAR EPOXY WAS ABRADED OFF AND A CARBOLENE LINER WAS INSTALLED. THIS LINING HAS BEEN FLAKING OFF IN PLACES.

THE PH PROBES AND PH MONITORING SYSTEM ARE BEING REDESIGNED SINCE THE SYSTEM CURRENTLY IN USE SEEMS TO BE CONTINUALLY OUT OF CALIBRATION. AN ULTRASONIC CLEANER WAS INSTALLED BUT IS NOT WORKING WELL. THE PH MONITORING SYSTEM IS A DUAL PROBE SYSTEM WHICH ALLOWS A PROBE TO BE IN USE WHILE THE OTHER IS CLEANED.

4TH QUARTER-1978 DURING THE REPORT PERIOD THE SCRUBBERS WERE RECONSTRUCTED. NEW HASTELLOY-G MIST ELIMINATORS WERE INSTALLED, AS DESCRIBED IN 2ND QUARTER-1978. WORK IS SCHEDULED TO BEGIN ON INSTRUMENTATION MODIFICATIONS ABOUT MID-JANUARY. THESE INCLUDE REMOVAL OF THE FLUE GAS FLOW SENSORS AND INSTALLATION OF A NEW PH MONITORING SYSTEM. WORK WILL BE DONE ON ONE MODULE AT A TIME, AND ONLY 48 HOURS OF MUTUAL DOWNTIME ARE EXPECTED FOR HOOK-UP. THE PHENOL SCRUBBER LINING SUPPLIED BY CARBOLINE HAS FLAKED OFF. NO PLANS CURRENTLY EXIST TO RELINE THE SCRUBBERS.

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GENERAL MOTORS CORPORATION
INSTALLATION LOCATION	PARMA, OHIO
SOURCE CHARACTERISTICS	COAL (2.5% SULFUR)
SOURCE RATING	128,400 SCFM (TOTAL - 4 BOILERS) 320,000 LB/HR STEAM (TOTAL)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	4
SOURCE CAPACITY	64 MW (EQUIVALENT); TOTAL - 4 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	GM ENVIRONMENTAL
CONTROL PROCESS	DOUBLE ALKALI (DILUTE)
NEW / RETROFIT	RETROFIT
START-UP DATE	MARCH, 1974
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90% (800-1300 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	83% (AT INLET: UNITS 1&2 - 1.75 LB/MIN; UNITS 3&4 - 1.22 LB/MIN)
WATER MAKE-UP	CLOSED LOOP
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL 50+% SOLIDS (CASO3/SO4) SLUDGE TO DRYING POND AND LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE CHEVROLET PARMA PLANT OF GENERAL MOTORS IS LOCATED NEAR CLEVELAND, OHIO. THE PLANT HAS FOUR SPREADER-STOKER BOILERS FIRED BY TRAVELING GRATES, CAPABLE OF PRODUCING A TOTAL OF 320,000 LB/HR OF STEAM AND GENERATING 128,400 SCFM OF FLUE GAS, WHICH IS EQUIVALENT TO ABOUT 64 MW OF ELECTRICAL CAPACITY. THE COAL FIRED IN THESE UNITS ORIGINATES PRIMARILY FROM THE SOUTHEASTERN PORTION OF OHIO AND HAS THE FOLLOWING AVERAGE CHARACHTERISITICS: HEAT CONTENT OF 11,300 BTU/LB, SULFER CONTENT OF 1.7 TO 2.7 PERCENT, ASH CONTENT OF 6.8 TO 14.8 PERCENT, AND A TOTAL MOISTURE CONTENT OF 7.8 PERCENT.

THE POWER BOILERS HAVE AN EMISSION CONTROL SYSTEM CONSISTING OF CYCLONE-TYPE MECHANICAL COLLECTORS UPSTREAM OF A DILUTE DOUBLE ALKALI SCRUBBING SYSTEM. THE FGD SYSTEM SCRUBBING MODULES WERE SUPPLIED BY KOCH ENGINEERING. INSTALLATION WAS COMPLETED ON FEBRUARY 28, 1974. THE SYSTEM CONSISTS OF FOUR SCRUBBERS OPERATING IN PARALLEL. EACH SCRUBBER CONTAINS THREE BUBBLE-CAP ABSORPTION TRAYS AND A MESH MIST ELIMINATOR. THE FLUE GAS RATE IS 61,500 ACFM AT 393 F FOR EACH OF THE FIRST TWO SCRUBBERS AND THE OUTLET TEMPERATURE IS 137 F. THE INLET SO2 CONCENTRATION IS 765 PPM. THE FLUE GAS FLOW RATE IS 58,600 ACFM AT 550 F FOR THE OTHER TWO SCRUBBERS AND THE OUTLET TEMPERATURE IS 152 F. THE INLET SO2 CONCENTRATION IS 800-1300 PPM. OUTLET CONCENTRATION VARIES

GENERAL MOTORS CORPORATION; PARMA, OHIO (CONTINUED)

FROM 136-220 PPM FOR THE SCRUBBERS.

THE SULFUR DIOXIDE CONTAINED IN THE BOILER FLUE GAS IS ABSORBED BY A REGENERATED CAUSTIC SOLUTION (0.1 MOLAR NAOH), FORMING A SOLUTION OF SOLUBLE SODIUM SALTS. THE SPENT CAUSTIC IS THEN REGENERATED BY REACTING THE SODIUM SALT SOLUTION WITH SLAKED LIME, RESULTING IN THE FORMATION OF CALCIUM SULFITE/SULFATE SOLIDS, WHICH ARE SEPARATED OUT OF THE SOLUTION. NEXT, SODA ASH IS ADDED TO THE SOLUTION IN ORDER TO MAKE UP FOR SODIUM LOSSES AND MINIMIZE THE SCALE POTENTIAL FROM THE CALCIUM WHICH REMAINS IN SOLUTION. THE REGENERATED CAUSTIC FORMED IS THEN RECYCLED BACK TO THE SCRUBBER FOR ADDITIONAL SULFUR DIOXIDE REMOVAL. THE CALCIUM SALT AND FLY ASH SLUDGE WHICH RESULTS IS DEWATERED AND HAULED AWAY BY TRUCK TO AN OFF-SITE LANDFILL.

EQUIPMENT SPECIFICATIONS

SCRUBBERS. EACH OF THE 4 SCRUBBERS IS 10.5 FT DIA X 22.5 FT HIGH X 11 GAUGE THICK AND CONTAINS 3 BUBBLE-CAP TRAYS. ALL THE SCRUBBERS AND TRAYS ARE MADE OF 316L SS. THE SCRUBBERS HAVE A TURNDOWN RATIO OF 3 AND ALSO HAVE A BYPASS DUCT. THE DESIGN L/G RATIO IS 20 GALLONS/ACF BUT THIS MAY BE VARIED DURING OPERATION. THE PRESSURE DROP ACROSS THE SCRUBBER RANGES BETWEEN 8-9 IN. WG.

DEMISTERS. ORIGINAL 316 SS MIST ELIMINATORS WERE CORRODED DUE TO CONDENSATION AND WERE REPLACED BY FLEXIMESH-TYPE POLYPROPYLENE MIST ELIMINATORS.

RECYCLE TANKS/PUMPS. ALL THE 4 RECYCLE TANKS ARE MILD STEEL WITH TAR TYPE RESIN COATING. THE PUMPS (6 TOTAL, 2 SPARE) ARE CENTRIFUGALS WITH MILD STEEL CASING AND HAVE RUBBER LININGS. THE PUMP MOTORS ARE 40 HP.

CHEMICAL MIX TANKS & AGITATORS. BOTH THE MIX TANKS ARE MILD STEEL WITH 5000 GALLONS CAPACITY. THE DESIGN RESIDENCE TIME IS 7 MINUTES. NEW AGITATORS ARE PROPELLER TYPE. THESE ARE SPECIALLY DESIGNED TO GIVE HIGHER FLOW RATE THROUGH THE BLADES. THE DRIVE RATINGS ARE 5 HP AND 85 RPM.

CLARIFIERS. BOTH THE CLARIFIERS (60 FT DIA X 14 FT LIQUID DEPTH) HAVE A CONICAL BOTTOM AND 300,000 GALLONS CAPACITY. THE DESIGN RETENTION TIME IS ABOUT 4 HOURS AT A FLOW RATE OF 1200 GPM.

VACUUM FILTERS. BOTH THE VACUUM FILTERS HAVE 500 SQ. FT. OF SURFACE AREA WITH A 10 FT DRUM DIAMETER. THE DRUM DRIVE SPEED IS 0.5 RPM MAXIMUM.

FILTRATE TANK/PUMPS. THE TANK (4 FT DIA X 7 FT HIGH) IS MILD STEEL AND HOLDS 660 GALLONS OF FILTRATE. THE PUMPS ARE MILD STEEL, CENTRIFUGAL AND HAVE A CAPACITY OF 300 GPM AT 15 FT. OF HEAD.

EARLY PROBLEMS AND SOLUTIONS

THE SYSTEM WAS STARTED UP ON FEBRUARY 28, 1974 AND BY APRIL 31, IT HAD OPERATED FOR 264 HOURS. THERE WERE TWO SCHEDULED SHUTDOWNS DURING THIS PERIOD FOR EQUIPMENT INSPECTION. THE SECOND SHUTDOWN

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GENERAL MOTORS CORPORATION; PARMA, OHIO (CONTINUED)

REVEALED THAT SOLIDS WERE NOT BEING DISCHARGED FROM THE PRIMARY CLARIFIER RAPIDLY ENOUGH. AS A RESULT, THE CLARIFIER RAKE JAMMED. A PIPING CHANGE WAS MADE TO BLEND THE CAUSTIC FEED IN WITH THE RECYCLE LIQUOR. THIS IMPROVED PERFORMANCE BUT DID NOT COMPLETELY ELIMINATE THE PROBLEM. PREMATURE CAKE CRACKING IN THE VACUUM FILTERS REQUIRED THE PRESENCE OF AN OPERATOR DURING OPERATION. CAKE WASHING TO REDUCE LOSSES WAS NOT INITIALLY SUCCESSFUL BECAUSE THE SPRAY WATER TENDED TO KNOCK THE CAKE OFF THE DRUM. ALTERATIONS IN SPRAY PATTERN AND OTHER MEASURES APPARENTLY SOLVED THIS PROBLEM. THERE WAS NO EVIDENCE OF CORROSION OR ABRASION IN THE PUMPS OR PIPING.

THE SYSTEM WAS SHUT DOWN FROM MAY 1 TO MAY 28, 1974, BECAUSE OF UNEXPECTED BUILDUP OF SOLIDS IN THE CLARIFIER, WITH SUBSEQUENT OVERFLOW INTO THE SCRUBBER. THE PROBLEM WAS SOLVED BY 1: USING A POLYMERIC FLOCCULATION AGENT TO ATTAIN BETTER SETTLING AND 2: WITHDRAWING SLUDGE FROM THE CLARIFIER AT MORE FREQUENT INTERVALS. SYSTEM AVAILABILITY TO THE BOILER WAS 87 PERCENT IN APRIL 1974, LESS THAN 10 PERCENT IN MAY, AND 100 PERCENT IN JUNE, JULY, AND AUGUST AFTER THE SYSTEM WAS RESTARTED. PLUGGING BY GYPSUM DEPOSITS IN THE OVERFLOW LINE BETWEEN THE CLARIFIERS AND IN THE LINE FROM CLARIFIER NO. 2 TO THE MIX TANKS WAS CORRECTED BY RELOCATING A CHEMICAL FEED LINE AND REPLACING SOME PIPING. THE SYSTEM WAS DOWN THROUGH JULY AND AUG. 1975 FOR REPLACEMENT OF GRAVITY FLOW LINES WITH AN OPEN FLUME THAT CAN BE EASILY CLEANED. THE OPERABILITY INDEX FOR THE FGD SYSTEM INCREASED SIGNIFICANTLY THROUGHOUT THE COURSE OF 1976.

REFER TO FIGURE 14-16 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

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        OPERATION HOURS
MONTH   BOILER  FGD SYSTEM  OPERABILITY (%)
MAY-JUN. 75
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THE SYSTEM WAS RESTARTED AND PARTICULATE TESTS WERE CONDUCTED IN MAY. THE SYSTEM WAS SHUT DOWN DUE TO PLUGGED CHEMICAL FEED LINE TO THE CLARIFIER AFTER RESTART. AROUND JUNE 10, THE SYSTEM WAS SHUTDOWN BECAUSE OF SIMILAR PLUGGING IN ANOTHER PART OF THE LINE. THE UNIT RAN FOR ABOUT TWO WEEKS IN JUNE.

JUL.-AUG. 75

THE FGD SYSTEM WAS DOWN IN JULY AND AUGUST FOR REPLACEMENT OF GRAVITY FLOW LINE WITH AN OPEN FLUME.

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OCT. 75   2331      1848          79
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THE FGD SYSTEM RESTARTED ON SEPTEMBER 8, AND OPERATED DURING THIS PERIOD AT AN AVAILABILITY FACTOR OF 80 PERCENT. THE FIGURES GIVEN FOR OCTOBER REPRESENT THE OPERATION HOURS FROM SEPTEMBER 8 TO NOVEMBER 9.

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DEC. 75   2135      1250           59
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HOLIDAY SHUTDOWN FROM 12/23 TO 1/4. DUE TO PROBLEMS WITH SOLIDS AND SOLIDS CARRY-OVER, G.M. CON-

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GENERAL MOTORS CORPORATION; PARMA, OHIO (CONTINUED)

OPERATION HOURS
MONTH BOILER FGD SYSTEM OPERABILITY (%)

DUCTED STREAM TESTS DURING DECEMBER TO DETERMINE WHETHER THE CARRY-OVER OF SOLIDS WAS DUE TO A HIGH SOLIDS RECIRCULATION RATE. THE FGD SYSTEM WAS DOWN MOST OF DECEMBER BECAUSE OF THESE TESTS, WHICH CAUSED THE LOW OPERABILITY FACTOR.

FEB. 76 2997 1196 40

G.M. HAS FOUND SOLIDS CONCENTRATION IN THE CLARIFIER TOO HIGH FOR EFFICIENT SYSTEM OPERATION. A.D. LITTLE WAS SCHEDULED TO CONDUCT TESTS ON THE SYSTEM IN APRIL AS PART OF AN EPA EVALUATION PROGRAM.

MAR. 76 1379 240 7
APR. 76 1084 847 78

THE LOW OPERABILITY INDEX DURING THE MONTH OF MARCH RESULTED FROM EXTENSIVE MODIFICATIONS PERFORMED ON THE SYSTEM BY G.M. DURING THIS PERIOD THE SCRUBBER BLOWDOWN AND SCRUBBER FLOW INDICATION SYSTEM WAS REVISED. FROM APRIL 19 TO THE END OF THE MONTH THE SYSTEM WAS OPERABLE 100%. DURING THIS PERIOD ALL SYSTEM MODIFICATIONS WERE COMPLETED AND ALL MAJOR PROBLEM AREAS CORRECTED.

MAY 76 1149 1042 91
JUN. 76 924 816 88

ONE SYSTEM UPSET OCCURRED DURING THE PERIOD DUE TO AN OPERATOR ERROR. BOILER HOURS WERE LOW IN JUNE BECAUSE OF LOW PROCESS DEMAND. THE SCRUBBING SYSTEM CHARACTERIZATION STUDY WAS CONCLUDED ON MAY 14.

JUL. 76 599 599 100
AUG. 76 715 715 100

THE BOILER LOAD DEMAND WAS VERY LIGHT DURING THE REPORT MONTHS, REQUIRING ONLY ONE BOILER BEING CONTINUOUSLY ON LINE. THE SYSTEM WAS DOWN FOR A ONE-WEEK PERIOD BECAUSE OF THE ANNUAL PLANT INVENTORY. MODIFICATIONS TO THE OPERATION OF THE OF THE GAS SCRUBBING SYSTEM HAVE INCLUDED:

ELIMINATION OF POLYMERIC ADDITION.

ELIMINATION OF SLUDGE BLANKET FOR FILTRATION.

HIGH PERCENT SULFATE CONCENTRATION IN THE FILTER CAKE.

INCORPORATION OF PH CONTROLLER IN THE CHEMICAL MIX TANK REGULATING THE LIME FEED INTO SYSTEM. PH CONTROL SHOULD REDUCE THE STOICHIOMETRIC REQUIREMENTS FROM THE 1.25-1.50 RANGE DOWN TO 1.10-1.20.

SEP. 76 809 223 40
OCT. 76 1174 734 63

TWO BOILERS AND THEIR CORRESPONDING SCRUBBER MODULES WERE IN SERVICE DURING THE MONTH. OPERATION TIME WAS LOGGED PRIMARILY IN THE INITIAL PART OF THE MONTH. A NUMBER OF PROBLEMS WERE ENCOUNTERED, FORCING A SHUTDOWN THROUGHOUT THE REMAINDER OF THE MONTH. THESE INCLUDED:

SOLIDS DEPOSITION AND PLUGGING OF THE CHEMICAL TANKS AND REACTORS, REQUIRING SHUTDOWN/CLEANOUT.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS IN INDUSTRIAL BOILERS

GENERAL MOTORS CORPORATION; PARMA, OHIO (CONTINUED)

	OPERATION HOURS		
MONTH	BOILER	FGD SYSTEM	OPERABILITY (%)

REPLACEMENT OF DEMISTER PADS.

AGITATOR PROBLEMS.

THE SYSTEM WAS RETURNED TO SERVICE THE SECOND WEEK IN OCTOBER. TWO BOILERS AND THEIR CORRESPONDING SCRUBBERS WERE PUT BACK IN THE GAS STREAM. PROBLEMS ENCOUNTERED STEMMED PRIMARILY FROM A MECHANICAL COLLECTOR MALFUNCTIONING RESULTING IN EXCESSIVE PARTICULATE LOADING IN THE MODULES AND EVENTUALLY CAUSING WIDESPREAD PLUGGING OF THE LOWER BUBBLE-CAP TRAYS. SHUTDOWN AND CLEANOUT OF MODULES PLUS REPAIRS TO THE MECHANICAL COLLECTOR WERE REQUIRED. SYSTEM RESTART OCCURRED NOVEMBER 8.

MAJOR MODIFICATIONS PERFORMED TO THE DOUBLE ALKALI SYSTEM DURING THE PERIOD INCLUDED THE INSTALLATION OF A GREAT LAKES PH MONITOR AND CONTROL UNIT FOR THE REGULATION OF LIME FEED TO THE REGENERATION REACTOR-CLARIFIER UNIT. THIS UNIT EMPLOYS A DIGITAL READOUT AND WAS SCHEDULED FOR OPERATION SOMETIME IN NOVEMBER. SUPERIOR CRYSTAL GROWTH OF THE CALCIUM SULFITE/SULFATE SALTS RESULTED BY RUNNING A SEEDING LINE BACK TO THE REACTOR-CLARIFIER UNIT.

NOV. 76	1321	787	60
DEC. 76	1559	349	22

DURING THE LATTER PART OF NOVEMBER AND EARLY DECEMBER, THE SCRUBBERS WERE TAKEN OUT OF THE FLUE GAS PATH BECAUSE OF CONTINUED SOLIDS BUILDUP IN THE MIX TANK. IN ADDITION, SOME PIPING ARRANGEMENTS WERE MODIFIED AND THE GEAR REDUCER IN THE MIX TANK HAD TO BE REPLACED. THE FGD FIGURES REPORTED FOR THE MONTH OF DECEMBER ARE NOT FULLY REPRESENTATIVE BECAUSE IT IS PART OF THE LOCAL UAW CONTRACT THAT ONLY UAW PERSONNEL CAN OPERATE THE FGD SYSTEM AND THEREFORE THE SCRUBBERS COULD NOT BE OPERATED.

JAN. 77	1852	608	33
FEB. 77	1462	892	61

THERE WAS A FAILURE OF THE AGITATORS AT THE MIX TANKS. THEY WERE LATER REPLACED WITH NEW ONES. THE PLANT WAS SHUTDOWN FOR SOME PERIOD DUE TO CUTBACK OF NATURAL GAS SUPPLY AND REQUEST TO CURTAIL ELECTRICAL CONSUMPTION.

APR. 77	1300	1158	89
MAY 77	1222	1118	92

BOILER HOURS WERE LOW DUE TO REDUCED SUMMER REQUIREMENTS.

JUN. 77	1180	1103	94
JUL. 77	702	276	39

THE FGD SYSTEM GAVE A VERY HIGH OPERABILITY FOR JUNE. THE FGD SYSTEM WAS DOWN FOR A CONSIDERABLE PORTION OF JULY. THE CHEMICAL MIX TANK BLEED OFF LINES AND OTHER PIPING HAD TO BE CLEANED OF SEDIMENTED SOLIDS.

AUG. 77	755	678	90
SEP. 77	764	480	71

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GENERAL MOTORS CORPORATION; PARMA, OHIO (CONTINUED)

DURING THIS LOW-LOAD PERIOD THE LIME FEED PUMP AND LIME FEED LINES WERE CLEANED. GENERALLY, EVERY SUMMER AN ANNUAL FGD OVERHAUL IS CARRIED OUT.

	OPERATION HOURS		
MONTH	BOILER	FGD SYSTEM	OPERABILITY (%)
OCT. 77	1277	398	31
NOV. 77	1380	926	67
DEC. 77	1790	968	54

THE CHEMICAL MIX TANK AGITATORS WERE TOTALLY REDESIGNED AND REPLACED BY HIGH-CARBON STEEL, PROPELLER TYPES. THE BLADES WERE SPECIFICALLY DESIGNED TO INCREASE THE FLOW THROUGH THE PROPELLERS, THUS INCREASING THE INTENSITY OF MIXING. DUE TO THANKSGIVING HOLIDAYS IN NOVEMBER AND CHRISTMAS AND NEW YEAR HOLIDAYS IN DECEMBER, THE FGD SYSTEM HAD LOWER OPERATION HOURS. SOME OF THE BOILERS HAD TO BE RUN FOR BUILDING MAINTENANCE.

1ST QUARTER-1978 THE BOILERS OPERATED FOR 3370 HOURS WHEREAS THE FGD OPERATED FOR 70 HOURS. THE OPERABILITY INDEX WAS THEREFORE 1.25%. THE RAKE SHAFT IN THE THICKENER WAS BROKEN IN EARLY JANUARY. THERE WAS A CONSIDERABLE DELAY IN RECEIVING REPLACEMENT PARTS. IN ADDITION, SEVERE WINTER (BLIZZARD, HEAVY SNOW) MADE IT IMPOSSIBLE TO PERFORM ANY REPAIRS.

2ND QUARTER-1978 THE FGD SYSTEM OPERATED FOR 2669 HOURS, AND THE BOILERS OPERATED FOR 3414 HOURS. THE OVERALL OPERABILITY WAS 78.2 PERCENT. IN APRIL, THE PIPELINES WERE FLUSHED AND CHEMICAL TANKS WERE CLEANED ALONG WITH SCRUBBER INTERNALS, STACKS AND MIST ELIMINATORS. IN JUNE, THE AVAILABILITY WAS 100 PERCENT. DURING THE SUMMER QUARTER, USUALLY A LOW-LOAD PERIOD, SEVERAL MODIFICATIONS WERE SCHEDULED. NEW VACUUM PUMPS AND FILTERS WILL BE INSTALLED, AND THE LIME SLURRY FEED PUMPS WILL BE REPLACED BY DIAPHRAGM PUMPS TO AVOID PLUGGING OF CONTROL VALVES. THE NEW FILTER CLOTH, MADE OF POLYPROPYLENE, HAS GIVEN MUCH LONGER FILTERING LIFE (ABOUT 3 MONTHS) THAN THE OLD ONE, MADE OF NYLON. THIS IS DUE TO THE POOR FILTERING CHARACTERISTICS OF THE NYLON (PLUGGING).

3RD QUARTER-1978 FOR THIS PERIOD THERE HAS BEEN NO DOWNTIME DUE TO EQUIPMENT OR PROCESS FAILURE. WARREN-RUPP DIAPHRAGM PUMPS WERE INSTALLED TO REPLACE THE EXISTING LIME SLURRY FEED PUMPS. THE PLANT REPORTED 100% OPERABILITY.

4TH QUARTER-1978 DURING OCTOBER AND NOVEMBER THE BOILERS OPERATED 2815 HOURS AND THE FGD SYSTEM OPERATED 670 HOURS FOR AN OPERABILITY OF 23.8%. NEW FRP STACKS (4.5 FT. DIA. X 38 FT. HIGH) WERE MOUNTED ON TOP OF THE ABSORBERS, REPLACING THE OLD STAINLESS STEEL-LINED ONES WHICH WERE BADLY CORRODED. MODIFICATIONS WERE MADE TO THE TOP OF THE SCRUBBERS. THESE INCLUDED ENLARGING THE OPENING TO THE STACK TO REDUCE THE GAS VELOCITY, AND REPLACING THE FLEXIMESH MIST ELIMINATOR WITH A POLYPROPYLENE CHEVRON DEMISTER. DURING THE RECONSTRUCTION, WATERLINES WERE TESTED IN PREPARATION

GENERAL MOTORS CORPORATION; PARMA, OHIO (CONTINUED)

FOR WINTER AND THE NEW VACUUM FILTER PUMPS WERE INSTALLED. PEAK BOILER LOADS FOR THIS WINTER ARE EXPECTED TO BE ABOUT 175,000 LBS/HOUR WITH 3 BOILERS OPERATING SIMULTANEOUSLY.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GENERAL MOTORS CORPORATION
INSTALLATION LOCATION	PONTIAC, MICHIGAN
SOURCE CHARACTERISTICS	COAL (0.84% SULFUR)
	ALSO WOOD, PAPER, AND CARDBOARD.
SOURCE RATING	107,300 SCFM (TOTAL - 2 BOILERS)
	350,000 LB/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	53 MW (EQUIVALENT); TOTAL - 2 BOILERS
	(FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	GM ENVIRONMENTAL
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	APRIL, 1976
	SYSTEM OPERATED TWO MONTHS IN EARLY 1973.
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	NOT DETERMINED
PARTICULATE REMOVAL EFFICIENCY	85%
WATER MAKE-UP	OPEN LOOP: 50 GPM
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL
	5% SOLIDS SLURRY DEWATERED AND TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE GENERAL MOTORS TRUCKS AND COACH PLANT LOCATED AT PONTIAC, MICHIGAN OPERATES SEVERAL BOILERS TO GENERATE STEAM FOR BUILDING HEAT AND PROCESS REQUIREMENTS. TWO OF THESE BOILERS, NOS. 6 AND 8, ARE SPREADER STOKERS AND FIRE A MIXTURE OF COAL (0.84% SULFUR) AND SOLID REFUSE (PAPER AND CARDBOARD). BOILER NO. 6, INSTALLED IN 1972 BY ERIE CITY, IS RATED AT 188 MM BTU/HR OR 150,000 LBS/HR OF STEAM. BOILER NO. 8, INSTALLED IN 1972 BY RILEY, IS RATED AT 250 MM BTU/HR OR 200,000 LBS/HR OF STEAM. THE PARTICULATE EMISSIONS ARE CONTROLLED BY MECHANICAL COLLECTORS SUPPLIED BY ZURN INDUSTRIES, DESIGNED TO OPERATE AT 93% EFFICIENCY, WITH A PRESSURE DROP OF ABOUT 3 IN. WG.

PEABODY ENGINEERING SUPPLIED 2 WET SCRUBBERS IN APRIL 1976, PRIMARILY FOR ADDITIONAL PARTICULATE CONTROL. EACH SCRUBBER(12 FEET DIA X 21.5 FEET HIGH) CONTAINS 3 IMPINGEMENT TRAYS AND OPERATES WITH AN L/G OF 5 GAL/1000 ACF. THE SCRUBBER EFFLUENT IS MIXED WITH CAUSTIC AND MAKEUP WATER IN A HOLD TANK, AND PUMPED TO A CLARIFIER. THE OVERFLOW IS RECYCLED TO THE SCRUBBER, THUS SIGNIFICANT SO2 CONTROL IS ACHIEVED. THE UNDERFLOW IS SENT TO A WASTE TREATMENT PLANT, WHERE THE FLYASH IS REMOVED AND LANDFILLED. THE EFFLUENT DISCHARGE FROM THE WASTE TREATMENT PLANT IS 10 - 25 GPM.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GENERAL MOTORS CORPORATION; PONTIAC, MICHIGAN (CONTINUED)

THE SCRUBBERS, TRAYS, AND MIST ELIMINATORS (RADIAL VANE TYPE) ARE ALL MADE OF 316L SS.

REFER TO FIGURE 14-17 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

2ND QUARTER-1976 UNSTABLE PH CONTROL AND WEAR OF MECHANICAL EQUIPMENT HANDLING THE FLYASH SLURRY WERE MAJOR STARTUP PROBLEMS.

3RD QUARTER-1977 AN AVAILABILITY OF 100 PERCENT HAD BEEN REPORTED WHEN BURNING A MIXTURE OF COAL AND REFUSE. THE SCRUBBER DISCHARGE SLURRY CAUSED WEAR DUE TO ITS FLYASH CONTENT.

4TH QUARTER-1977 FLYASH ABRASION IN THE PUMPS AND PIPING CONTINUED TO BE THE PROBLEM.

1ST QUARTER-1978 FLYASH CAUSED SERIOUS EROSION OF LIQUID HANDLING EQUIPMENT.

2ND QUARTER-1978 IT WAS DECIDED TO INSTALL PRESSURE FILTERS IN THE SCRUBBER EFFLUENT LINES TO REMOVE FLYASH.

3RD QUARTER-1978 THE PRESSURE FILTERS WERE INSTALLED AND ARE WORKING WELL. NO OTHER PROBLEMS OCCURRED DURING THE REPORT PERIOD.

4TH QUARTER-1978 NO NEW OPERATING PROBLEMS DEVELOPED DURING THIS REPORT PERIOD. THE PRESSURE FILTERS WERE INSTALLED IN THE RECIRCULATION PIPING BETWEEN THE RECYCLE PUMP AND THE INLET TO THE ABSORBER. THEIR PERFORMANCE THUS FAR HAS BEEN RATED AS EXCELLENT.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GENERAL MOTORS CORPORATION
INSTALLATION LOCATION	ST. LOUIS, MISSOURI
SOURCE CHARACTERISTICS	COAL (3.2% SULFUR)
SOURCE RATING	64,000 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	32 MW (TOTAL - 2 BOILERS) (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	A.D. LITTLE
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	1972
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90+% (2000 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	REMOVED BY PRECEDING CYCLONE AND ESP
WATER MAKE-UP	OPEN LOOP
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO CITY SEWER NA2SO3 OXIDIZED TO NA2SO4, PH NEUTRALIZED AND DISCHARGED TO CITY SEWER SYSTEM
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE GENERAL MOTORS CORPORATION PLANT LOCATED IN ST. LOUIS, MISSOURI OPERATES 4 COAL-FIRED BOILERS. TWO OF THESE BOILERS, ONE PULVERIZED COAL-FIRED AND THE OTHER A SPREADER STOKER, ARE RATED AT A TOTAL OF 250,000 LB/HR STEAM AND GENERATE ABOUT 64,000 SCFM OF FLUE GAS. COAL COMPOSITION IS TYPICALLY 3.2% SULFUR AND 10% ASH. THE ST. LOUIS SO2 EMISSION REGULATION OF 1.4 LBS/MM BTU APPLIES ONLY FROM OCTOBER THROUGH MARCH, AND THE SCRUBBERS OPERATE ONLY DURING THIS PERIOD. FLUE GAS FROM ALL FOUR BOILERS EXITS THROUGH A COMMON STACK AND SUFFICIENT FLUE GAS FROM THE TWO CONTROLLABLE BOILERS IS SCRUBBED TO MAINTAIN THE REGULATION AT THE STACK OUTLET. THE REMAINING FLUE GAS BYPASSES THE SCRUBBERS, AND A COMPLEX DAMPER SYSTEM ALLOWS PLANT PERSONNEL TO VARY THE SCRUBBER/BYPASS RATIO. BOTH BOILERS ARE EQUIPPED WITH CYCLONES FOR PARTICULATE REMOVAL, AND THE PULVERIZED COAL UNIT ALSO UTILIZES AN ESP.

THE SCRUBBER CONSISTS OF A THREE-STAGE IMPINGEMENT TOWER WITH A CHEVRON MIST ELIMINATOR. THE SYSTEM IS EQUIPPED WITH DIRECT STEAM COIL REHEAT. THE TRAY TOWER AND MIST ELIMINATOR ARE CONSTRUCTED OF 316L STAINLESS STEEL.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GENERAL MOTORS CORPORATION; ST. LOUIS, MISSOURI (CONTINUED)

OPERATING HISTORY

3RD QUARTER-1977	AN OPERABILITY OF 100% WAS REPORTED DURING THE MAY-AUGUST PERIOD.
4TH QUARTER-1977	IN SPITE OF A CHEVRON DEMISTER AND 60 F REHEAT, THE STACK LINER WAS CORRODED.
1ST QUARTER-1978	THE DUCTWORK DOWNSTREAM OF THE SCRUBBERS DEVELOPED SOME LEAKS.
2ND QUARTER-1978	A HORIZONTAL PORTION OF THE DOWNSTREAM DUCTWORK,ABOUT 15-20 FEET IN LENGTH, WILL BE REDESIGNED TO AVOID STAGNATION OF EXHAUST GASES
3RD QUARTER-1978	THE DOWNSTREAM DUCTWORK WAS RECONSTRUCTED DURING THE REPORT PERIOD.
4TH QUARTER-1978	NO NEW FGD-RELATED PROBLEMS HAVE DEVELOPED DURING THE REPORT PERIOD, HOWEVER, THE PLANT HAS REPORTED THAT PLUME OPACITY HAS BECOME A PROBLEM.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GENERAL MOTORS CORPORATION
INSTALLATION LOCATION	TONOWANDA, NEW YORK
SOURCE CHARACTERISTICS	COAL (1.2% SULFUR)
SOURCE RATING	92,000 SCFM (TOTAL - 4 BOILERS) 36,000 ACFM @ 406 F, FOR EACH OF 3 FGD SYSTEMS 39,600 ACFM @ 350 F, FOR 1 FGD SYSTEM 340,000 LB/HR STEAM (TOTAL - 4 BOILERS)
NUMBER OF SEPARATE FGD UNITS	4
NUMBER OF BOILERS BEING CONTROLLED	4
SOURCE CAPACITY	46 MW (EQUIVALENT); TOTAL - 4 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	JUNE, 1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90%-95% (1,000 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	90% (1.0 LB/MM BTU AT INLET)
WATER MAKE-UP	OPEN LOOP
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL FLY ASH AND NA2SO3/SO4 WASTE LIQUOR DEWATERED AND THEN TO SANITARY LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE CHEVROLET DIVISION OF GENERAL MOTORS HAS A MOTOR PRODUCTION PLANT AT TONOWANDA, NEW YORK. THERE ARE 4 COAL-FIRED BOILERS AT THE FACILITY WHICH BURN 1.16 PERCENT SULFUR COAL WITH A HEATING VALUE OF 12,650 BTU/LB. THE TOTAL COAL FEED RATE IS 17 TONS/HR WHICH IS EQUIVALENT TO 412 MM BTU/HR WHICH IS EQUIVALENT TO 46 MW OF ELECTRICAL GENERATION.

ONE SCRUBBER HANDLES 39,000 ACFM AT 350 F WHEREAS EACH OF THE OTHER THREE 36,000 ACFM AT 406 F. THERE IS A CYCLONE BEFORE AND AFTER SCRUBBER FOR DUST COLLECTION AND MIST REMOVAL PURPOSES, RESPECTIVELY. THE VARIABLE THROAT VENTURI SCRUBBERS WERE SUPPLIED BY FMC CORP. THE PH OF RECYCLE SCRUBBER LIQUOR IS CONTROLLED AT 7.0 AND A L/G RATIO OF 20 GALLONS/1000 ACF IS USED. PRESSURE DROP ACROSS EACH SCRUBBER IS 10 IN. WG. CAUSTIC SODA IS ADDED TO THE SPENT LIQUOR IN A SEPARATE RECYCLE TANK. THE BLEED OFF RATE FROM THE RECYCLE TANK VARIES FROM 25 - 100 GPM. THE DISCHARGE CONTAINS FLYASH AND SODIUM SULFATE. THE FLYASH IS CONTROLLED AT LESS THAN 1% SUSPENDED SOLIDS. THE EFFLUENT IS DISCHARGED TO THE WASTE TREATMENT PLANT AFTER AERATION. THE AVERAGE INLET CONCENTRATIONS ARE

GENERAL MOTORS CORPORATION; TONOWANDA, NEW YORK (CONTINUED)

0.85 LB/MM BTU OF SO_2 AND 1 LB/MM BTU OF PARTICULATE. THE EFFICIENCY OF SO_2 REMOVAL IS 90% WHEREAS THAT OF PARTICULATE REMOVAL IS 80%-95%.

EACH SCRUBBER AND THE CYCLONIC DEMISTER IS MADE OF 316L SS. PLUME REHEAT IS NOT INCORPORATED INTO THE SYSTEM. THE ENERGY REQUIREMENTS FOR THE SYSTEM ARE ABOUT 3 - 5% OF THE FUEL BURNED.

REFER TO FIGURE 14-18 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1977 AVERAGE OPERABILITY DURING THIS PERIOD WAS REPORTED TO BE 100%.

4TH QUARTER-1977 MAJOR PROBLEMS HAVE BEEN PH CONTROL AND RECYCLE PIPE EROSION. CONTROL SENSORS/MODULATING MIXER VALVE REPLACED FOR PH CONTROL AND CAST IRON PIPE WAS USED TO REPLACE SS RECYCLE PIPING. DURING NOV - DEC CONDENSATION FOLLOWING THE DEMISTER HAS CORRODED THE STACK LINING. A DECISION HAS BEEN MADE TO RELINE THE STACK.

1ST QUARTER-1978 THE STACK HAS NOT RELINED.

2ND QUARTER-1978 ONE MORE CYCLONE WILL BE RETROFITTED AFTER EACH BOILER IN ORDER TO REDUCE THE PARTICULATE LOADING TO THE SCRUBBERS.

3RD QUARTER-1978 A MIST ELIMINATOR WILL BE INSTALLED TO PREVENT FURTHER CORROSION OF THE STACK LINER. THE LINER WILL EITHER BE REPLACED OR COATED WITH AN ACID-RESISTANT MATERIAL.

4TH QUARTER-1978 NO DEFINITE PLANS HAVE BEEN MADE REGARDING THE STACKS. THE ORIGINAL STACKS (MOUNTED ATOP THE ABSORBERS) ARE STAINLESS STEEL. THEY ARE CORRODED, BUT NOT BEYOND USE. THE MIST ELIMINATORS TO BE INSTALLED WILL BE CHEVRON-TYPE. THE MATERIAL HAS NOT BEEN SELECTED, BUT SOME SORT OF PLASTIC IS CONSIDERED LIKELY. THERE ARE NO PLANS TO ADD CYCLONES FOLLOWING THE BOILERS, A FACT ERRONEOUSLY REPORTED DURING THE 2ND QUARTER.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GEORGIA-PACIFIC PAPER CO.
INSTALLATION LOCATION	CROSSETT, ARKANSAS
SOURCE CHARACTERISTICS	BARK,COAL/OIL (1.5% - 2.0% SULFUR)
SOURCE RATING	220,000 SCFM (1 BOILER)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	110 MW (EQUIVALENT)
	(FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	AIRPOL INDUSTRIES
CONTROL PROCESS	CAUSTIC WASTE STREAM
NEW / RETROFIT	NEW
START-UP DATE	JULY, 1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	80% (500 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	90% (0.5 GR/SCF AT INLET)
WATER MAKE-UP	OPEN LOOP; SCRUBBED WITH 2,300 GPM "BLACK WATER" FROM PULP MILL.
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO CITY SEWER
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE FGD SYSTEM AT GEORGIA-PACIFIC PAPER CO., CROSSETT, ARKANSAS UTILIZES A CAUSTIC PULP MILL WASTEWATER STREAM (BLACK WATER) TO REMOVE PARTICULATE AND SO2 FROM FLUE GAS GENERATED BY A BARK/OIL OR BARK/COAL BOILER. THE BOILER IS AN ERIE CITY POWER BOILER RATED AT 600,000 LB/HOUR STEAM, AND GENERATES 220,000 SCFM OF FLUE GAS, WHICH IS EQUIVALENT TO 110 MW OF ELECTRICAL CAPACITY. THE NORMAL OPERATING RANGE IS BETWEEN 400,000 AND 500,000 LBS STEAM/HOUR WITH AN OPERATING SCHEDULE OF 24 HOURS/DAY, 359 DAYS/YEAR. IT IS ONE OF ELEVEN BOILERS THAT TURN 5 TURBINES AND GENERATE 45 MW.

THE FLUE GAS IS DUCTED TO A SINGLE SCRUBBER AT THE RATE OF 320,000 ACFM @ 310 F BY MEANS OF A BUFFALO FORGE I.D. FAN WHICH IS DRIVEN BY A 4000 HP WESTINGHOUSE TURBINE. THE SCRUBBER ITSELF IS MADE OF 304 SS AND CONSISTS OF AN UNLINED VENTURI THROAT (9.5 FT x 30 FT) AND A FIBERGLASS LINED LIQUID-GAS SEPARATOR (24 FT x 55 FT) WITH NO INTERNAL PARTS. THE DUCTWORK LEADING TO AND FROM THE SCRUBBER IS MADE OF STEEL AND THE DOWNSTREAM PORTION IS FIBERGLASS LINED. NO MIST ELIMINATOR OR RE-HEATER IS USED BECAUSE THE 304 SS STACK IS FIBERGLASS LINED. THE RECICULATION SYSTEM CONSISTS OF A 304 SS UNLINED RECIRCULATION TANK AND A 5000 GPM INGERSOLL-RAND PUMP. AN IDENTICAL SPARE PUMP IS ALSO ON HAND BUT IS NOT TIED INTO THE SYSTEM. THESE PUMPS ARE MADE OF 304 SS AND ARE RUBBER LINED. THEY OPERATE AT MAXIMUM CAPACITY. THE PIPING IS MADE OF FIBERGLASS. THE BLEED STREAM FROM THE RE-CIRCULATION SYSTEM IS FED TO THE CITY SEWERS AT A RATE OF 2000 GPM AND THE MAKE-UP SCRUBBING LIQUOR

GEORGIA-PACIFIC PAPER CO.; CROSSETT, ARKANSAS (CONTINUED)

IS FED TO THE SYSTEM AT A RATE OF 2300 GPM.

REFER TO FIGURE 14-19 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1977 PLANT REPORTED SATISFACTORY OPERATIONS WITH NO MAJOR PROBLEMS. THE FIBERGLASS LINING IN THE SCRUBBER FAILED FREQUENTLY AND WAS REPLACED AS IT FAILED.

4TH QUARTER-1977 NO FIBERGLASS LINER FAILURE WAS DETECTED DURING THIS REPORT PERIOD.

2ND QUARTER-1978 PLANT REPORTED NO MAJOR PROBLEMS DURING THE FIRST SIX MONTHS OF 1978. TOTAL BOILER-SCRUBBER DOWNTIME SINCE JANUARY 1, WAS ABOUT 15 DAYS. THE PROBLEMS WERE THE LOSS OF A PUMP LINER AND A BOILER I.D. FAN TROUBLE.

3RD QUARTER-1978 THE PUMP WITH LINING PROBLEMS WAS REPLACED. THIS CAUSED A SCRUBBER DOWN TIME OF APPROXIMATELY 36 HOURS. THE REASON FOR THE PUMP FAILURE IS UNKNOWN, BUT UNEVEN LINING APPLICATION IS LIKELY. THIS PUMP LASTED ROUGHLY 3 MONTHS BEFORE THE LINING OF THE IMPELLER BEGAN COMING OFF IN CHUNKS. THE NEW PUMP IS THE SAME TYPE AND HAS HAD NO PROBLEMS. THE SPARE IS ALSO OF THE SAME TYPE. SINCE REPLACEMENT OF THE RECIRCULATION PUMP THE SCRUBBER HAS OPERATED CONTINUOUSLY (SCRUBBER SHUTS DOWN WHEN THE RECIRCULATION PUMP GOES OUT).

4TH QUARTER-1978 NO OPERATING PROBLEMS WERE REPORTED DURING THIS SURVEY PERIOD. THE OPERATION OF THE RECIRCULATION PUMP WAS SATISFACTORY. THE BOILER WAS BURNING MOSTLY BARK SUPPLEMENTED WITH OIL. THE FGD SYSTEM DEMONSTRATED A RELIABILITY FIGURE OF 100%.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GETTY OIL COMPANY
INSTALLATION LOCATION	BAKERSFIELD, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.1% SULFUR)
SOURCE RATING	72,000 SCFM (TOTAL - 6 BOILERS)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	6
SOURCE CAPACITY	36 MW (EQUIVALENT); 6 BOILERS, EACH @ 50 MM BTU/HR
	(FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	JUNE, 1977
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90+% (600 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	HOLDING POND FOR EVAPORATION
	6 GPM BLEEDOFF TO A BLOWDOWN TANK. THE BLOWDOWN IS THEN SENT TO A DISPOSAL POND ONCE A WEEK.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

GETTY OIL COMPANY HAS AN OIL FIELD NEAR BAKERSFIELD, CALIFORNIA WHICH OCCUPIES ABOUT 15 SQUARE MILES. THERE ARE 136 STEAM GENERATORS; 100 WITH A HEAT RATE OF 50 MM BTU/HR AND 36 WITH A HEAT RATE OF 20 MM BTU/HR. THE FUEL USED IS CRUDE OIL WITH 1.1% SULFUR AND A HEATING VALUE OF 6.4 MM BTU/BBL. STEAM IS DISTRIBUTED THROUGHOUT THE OIL FIELD BY INSULATED PIPELINES AND INJECTED INTO THE OIL WELLS. CONDENSATION OF THE STEAM REDUCES THE VISCOSITY OF THE OIL, WHICH FLOWS FREELY TO THE SURFACE ALONG WITH THE WATER. THE OIL IS SEPARATED FROM WATER BY DECANTATION IN SETTLING TANKS, AND PURIFIED BY DISTILLATION IF REQUIRED.

THE FLUE GASES (130,000 ACFM @ 500 F) FROM SIX BOILERS (50 MM BTU/HR EACH) ARE MANIFOLDED INTO A TRAY ABSORBER (13.5 FEET DIA x 35 FEET HIGH) WHICH WAS RETROFITTED IN JUNE 1977 BY FMC ENVIRONMENTAL EQUIPMENT DIVISION. THE PROCESS IS SODIUM CARBONATE SCRUBBING. THE RECIRCULATION LIQUOR IS MAINTAINED AT A PH OF 6.8, WITH AN L/G RATIO OF 8.4 GAL/1000 ACF. THE RECIRCULATION FLOW IS 1000 GPM. A BLEED STREAM OF 6 GPM IS CONTINUALLY SENT TO THE BLOWDOWN TANK WHICH IS EITHER EMPTIED INTO A DISPOSAL POND OR INJECTED INTO DEEP WELLS EVERY WEEK. THE INLET SO2 CONCENTRATION IS 600 PPM. THE OUTLET IS 60 PPM. THE ABSORBER, THEREFORE, HAS 90% SO2 REMOVAL EFFICIENCY.

THE ORIGINAL ABSORBER CONTAINED THREE DISK-AND-DONUT TRAYS AND AN INCONEL WIRE MESH MIST ELIMINATOR. THE ABSORBER MODULE AND THE STACK ARE MADE OF 316L SS, WHEREAS THE DOWNSTREAM DUCTWORK AND THE RECIRCULATION PIPING ARE MILD STEEL. THE RECIRCULATION PUMP IS RUBBER LINED.

GETTY OIL COMPANY: BAKERSFIELD, CALIFORNIA (CONTINUED)

SOME IMPORTANT MAINTENANCE PRACTICES ARE:

1. DAILY CHECK AND CALIBRATION OF PH CONTROLLERS.
2. FREQUENT CHECKS ON FLOW METERS (MAKEUP WATER, SODA ASH, RECIRCULATION LIQUOR, AND BLOWDOWN) AND FLUID LEVELS (BLOWDOWN TANK, SODA ASH TANK, AND SCRUBBER).
3. WEEKLY FILLING OF SODA ASH TANK AND DISPOSAL OF BLOWDOWN.
4. SCHEDULED LUBRICATION OF PUMPS AND FAN, SEAL REPLACEMENT.

REFER TO FIGURE 14-21 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1977 THE RECIRCULATION PUMP LINER WAS CHANGED FROM BUNA-N TO NATURAL RUBBER, DUE TO THE SWELLING OF THE FORMER LINER. THE RUBBER PINCH VALVE ON THE RECIRCULATION PUMP WAS REPLACED BY A SS GLOBE VALVE. THERE WERE SOME MINOR PROBLEMS WITH THE PH AND LEVEL CONTROLLERS.

4TH QUARTER-1977 THE FAN ROTOR WAS STRENGTHENED AND CLEANED OF THE SCALING. THE FAN BEARING BURNED UP. IT WAS REPLACED AND THE FAN WAS REALIGNED.

1ST QUARTER-1978 HIGH STACK DISCHARGE VELOCITY (60 FPS) CAUSED BY SMALL STACK DIAMETER AND POOR LOCATION OF MIST ELIMINATOR (TOO CLOSE TO STACK TRANSITION SECTION) RESULTED IN HIGH ENTRAINMENT OF DROPLETS. THE STACK AND TOP SECTION OF THE SCRUBBER WERE REDESIGNED.

2ND QUARTER-1978 THE MESH DEMISTER WAS REPLACED BY A MUNTERS CHEVRON TYPE MIST ELIMINATOR. A KOCH FLEXITRAY WAS INSTALLED ABOVE THE 3RD TRAY IN ORDER TO IMPROVE SO_2 REMOVAL EFFICIENCY, PARTICULARLY DURING TURNDOWN CONDITIONS. THE PH PROBES ARE FOULED FREQUENTLY. SEVERAL TYPES OF CONTROLLERS ARE PRESENTLY BEING TESTED FOR HIGH RELIABILITY. THE MILD STEEL RECIRCULATION LINES WERE ERODED, AND WILL BE REPLACED BY 316L SS. THE AIR BUBBLER IN THE SODA ASH TANK LEVEL CONTROLLER IS OFTEN PLUGGED. IT WILL BE REPLACED BY A DIAPHRAGM-TYPE LEVEL CONTROL DEVICE. THE BLOWDOWN TANK OUTLET LINE HAS DEVELOPED SCALING. A POSITIVE DISPLACEMENT PUMP WAS TO BE INSTALLED IN THIS LINE, AND A SCALING INHIBITOR WAS POSSIBLY TO BE ADDED IN THE TANK LIQUOR.

3RD QUARTER-1978 THE BLOWDOWN TANK OUTLET LINE WAS REPLACED WITH A ONE-INCH LINE TO INCREASE VELOCITY AND THUS SOLVE THE SCALING PROBLEM. NEW 316L SS RECIRCULATION LINES HAVE BEEN INSTALLED, AS HAS THE DIAPHRAGM-TYPE LEVEL CONTROL DEVICE IN THE SODA ASH TANK. PH CONTROLLERS ARE STILL BEING TESTED. A SCREW-TYPE POSITIVE DISPLACEMENT PUMP WAS INSTALLED, REPLACING AN EARLIER PUMP WHICH ERODED DUE TO HIGH RPM. A SILICON DISPERSANT IS NOW BEING ADDED TO THE LIQUOR TO ASSIST IN ALLEVIATING THE SCALING PROBLEM, BUT THERE HAS NOT BEEN SUFFICIENT TIME TO EVALUATE ITS EFFECTIVENESS. SINCE AUGUST 7 THE SYSTEM HAS EXPERIENCED ONLY 2 DAYS DOWNTIME DUE TO REPLACEMENT OF FAN BEARINGS.

4TH QUARTER-1978 THE POSITIVE DISPLACEMENT (MOYNO) PUMP, WHICH HAS A NATURAL RUBBER STATOR AND

GETTY OIL COMPANY: BAKERSFIELD, CALIFORNIA (CONTINUED)

316L ROTOR HAS EXPERIENCED ABRASION ON THE ROTOR. EROSION IS CAUSED BY THE ASH COLLECTED IN THE SCRUBBER AND SCALING. SEVERAL OTHER MATERIALS SUCH AS CHROME-ALLOY AND NI-HARD ARE BEING REVIEWED AS REPLACEMENTS. THE BLEED-OFF STREAM FLOW IS CONTROLLED MANUALLY AS A FUNCTION OF ITS SPECIFIC GRAVITY (SET PH=1.15).

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GETTY OIL COMPANY
INSTALLATION LOCATION	BAKERSFIELD, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.1% SULFUR)
SOURCE RATING	495,000 SCFM (TOTAL-45 BOILERS) 5 FGD SYSTEMS, EACH TREATING 200,000 ACFM @ 500 F
NUMBER OF SEPARATE FGD UNITS	5
NUMBER OF BOILERS BEING CONTROLLED	45
SOURCE CAPACITY	245 MW (EQUIVALENT): 2250 MM BTU/HR (TOTAL-45 BOILERS) EACH BOILER RATED AT 42,000 LBS/HR STEAM (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	IN-HOUSE DESIGN
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	DECEMBER, 1978
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	96% (600 PPM SO2 @ INLET)
PARTICULATE REMOVAL EFFICIENCY	50% (35 LB/HR ASH @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO TAILINGS POND HOLDING POND FOR EVAPORATION. 9 GPM BLEEDOFF TO A BLOWDOWN TANK. THE BLOWDOWN IS EMPTIED INTO A DISPOSAL POND ONCE A WEEK.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

GETTY OIL, COMPANY HAS AN OIL FIELD NEAR BAKERSFIELD, CALFORNIA, WHICH OCCUPIES ABOUT 15 SQUARE MILES. THERE ARE 136 STEAM GENERATORS: 100 WITH A HEAT RATE OF 50 MM BTU/HR AND 36 WITH A HEAT RATE OF 20 MM BTU/HR. THE FUEL USED IS CRUDE OIL WITH 1.1% SULFUR AND A HEATING VALUE OF 6.4 MM BTU/BBL. STEAM IS DISTRIBUTED THROUGHOUT THE OIL FIELD BY INSULATED PIPELINES AND INJECTED INTO THE OIL WELLS. CONDENSATION OF THE STEAM REDUCES THE VISCOSITY OF THE OIL, WHICH FLOWS FREELY TO THE SURFACE ALONG WITH THE WATER. THE OIL IS SEPARATED FROM WATER BY DECANTATION IN SETTLING TANKS, AND PURIFIED BY DISTILLATION IF REQUIRED.

THE FLUE GASES (200,000 ACFM AT 500 F) FROM NINE BOILERS (50 MM BTU/HR EACH) ARE MANIFOLDED INTO ONE ABSORBER (18 FT DIA x 33 FT HIGH). EACH ABSORBER HAS 3 FLEXITRAYS AND ONE FLEXICHEVRON DEMISTER SUPPLIED BY KOCH ENGINEERING. THE OVERALL DESIGN OF THE FGD SYSTEMS, HOWEVER, IS PERFORMED INHOUSE BY GETTY OIL ENGINEERS. THE PROCESS USED IS SODIUM CARBONATE SCRUBBING. THE FLUE GASES ARE QUENCHED IN THE BOTTOM PART OF THE ABSORBER. THE RECIRCULATION LIQUOR PH IS MAINTAINED BETWEEN 6.5-6.8 AND HAS 17 PERCENT DISSOLVED SOLIDS BY WEIGHT. THE DESIGN L/G RATIO IS 9 GAL/1000 ACF AND

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GETTY OIL COMPANY; BAKERSFIELD, CALIFORNIA (CONTINUED)

THE FLOW TO THE TOP TRAY IS ABOUT 1300 GPM. A BLEED-OFF STREAM OF 9 GPM IS CONTINUOUSLY SENT TO A BLOWDOWN TANK, WHICH IS EMPTIED INTO A DISPOSAL POND ONCE A WEEK. THE ABSORBER IS DESIGNED TO REMOVE 96% OF SO2 (600 PPM AT INLET) AND ABOUT 50 PERCENT OF THE ASH (35 LB/HR AT INLET).

REFER TO FIGURE 14-20 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1978 OF THE 9 FGD SYSTEMS UNDER CONSTRUCTION, ONE WAS STARTED UP ON SEPT. 18, 1978 AND ANOTHER IS SCHEDULED FOR START-UP THE FIRST WEEK IN OCTOBER. THE LAST OF THE SYSTEMS IS SCHEDULED FOR START-UP BY MID FEBRUARY.

4TH QUARTER-1978 A TOTAL OF FIVE FGD SYSTEMS HAVE STARTED UP. THE MAIN STARTUP PROBLEMS AND THEIR SOLUTIONS ARE:

1. SCALING--THE STEAM CONDENSATE IS FILTERED, SOFTENED AND RECYCLED TO THE GENERATORS AND THE FGD SYSTEMS. STILL, SOME OF THE DISSOLVED SPECIES SEEM TO CAUSE SCALING IN THE ABSORBERS WHEN SUBJECTED TO A PH CHANGE. SILICON DISPERSANTS HAVE BEEN USED TO REDUCE THE SCALING.
2. FANS--MISALIGNMENT OF BEARINGS HAS BEEN A FREQUENT SOURCE OF HIGH VIBRATIONS. ALL THE FANS ARE FORWARD-CURVED-BLADE CENTIFUGAL TYPE, WITH A DESIGN RATING OF 11 IN WG. AT 500 HP. SOME OF THE FANS, HOWEVER, HAVE NOT BEEN ABLE TO GENERATE THE SPECIFIED POSITIVE PRESSURE. PROPER VENDOR SELECTION MAY BE THE SOLUTION.
3. MIST ELIMINATOR--IN ONE ABSORBER, THE FLEXI-CHEVRON MIST ELIMINATOR HAS ACHIEVED LOW DROPLET REMOVAL. THIS MAY BE DUE TO CHANNELING IN THE ABSORBER, AND THE PROBLEM IS UNDER INVESTIGATION. SOME OTHER CHEVRON MIST ELIMINATORS MAY BE EVALUATED. OUT OF THE 4 REMAINING UNITS, 2 ARE SCHEDULED TO START IN MID-JANUARY AND 2 IN MID-FEBRUARY 1979.

ONE FGD SYSTEM STARTED-UP IN DECEMBER 1978 IS USING SODIUM HYDROXIDE SCRUBBING IN AN ATTEMPT TO EVALUATE THE PERFORMANCE OF CAUSTIC AGAINST SODA ASH AS THE ALKALI. THE SODA ASH CONSUMPTION HAS BEEN VERY HIGH (2-2.2 LB/LB SO2 REMOVED) COMPARED TO THE STOICHIOMETRIC REQUIREMENT (1.7 LB/LB SO2 REMOVED, MAX.).

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GREAT SOUTHERN PAPER CO.
INSTALLATION LOCATION	CEDAR SPRINGS, GEORGIA
SOURCE CHARACTERISTICS	BARK,COAL/OIL (1.0% - 2.0% SULFUR)
SOURCE RATING	820,000 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	210 MW (EQUIVALENT): TOTAL - 2 BOILERS
	(FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	AIRPOL INDUSTRIES
CONTROL PROCESS	CAUSTIC WASTE STREAM
NEW / RETROFIT	RETROFIT
START-UP DATE	1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	85%-90% (1,000 PPM AT INLET)
PARTICULATE REMOVAL EFFICIENCY	99.1% (DESIGN: 4.5 GR/SCF AT INLET)
WATER MAKE-UP	OPEN LOOP: 350 - 400 GPM PER ABSORBER
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO RIVER
	CLARIFICATION FOLLOWED BY PONDING AND DISCHARGE TO RIVER
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

IN CEDAR SPRINGS, GEORGIA, THE GREAT SOUTHERN PAPER COMPANY OPERATES TWO 500,000 LB/HR BOILERS GENERATING A TOTAL OF 700,000 ACFM AT 425 F. THE BOILERS NORMALLY RUN AT NEARLY PEAK CAPACITY AND FIRE BARK AND COAL (1.5% SULFUR). A FUEL OIL BACK-UP SYSTEM IS ALSO AVAILABLE.

EMISSIONS FROM THE TWO BOILERS ARE HANDLED BY TWO AIRPOL VENTURI SCRUBBERS, EACH FOLLOWED BY A RADIAL VANE SEPARATOR AND A STUB STACK. PRESSURE DROP ACROSS THE SCRUBBER IS ABOUT 6 INCHES W.G., AND THE DESIGN SO2 REMOVAL EFFICIENCY IS 85-90%. THE SCRUBBERS OPERATE WITH AN L/G RATIO OF ABOUT 5 GAL/1000 ACF. THE INLET SO2 CONCENTRATION OF THE FLUE GAS IS TYPICALLY 1000-1200 PPM AND THE PARTICULATE LOADING IS 4.5 GR/SCFD.

SCRUBBER UNDERFLOW, CONTAINING FLYASH AND SODIUM SULFATE, GOES TO A COMMON STAINLESS STEEL RECIRCULATION TANK. SOLIDS CONTENT IN THE TANK IS 3-5% AND PH IS MAINTAINED AT 3.5-5 USING A 5% CAUSTIC WASTE STREAM FROM AN ONSITE DEMINERALIZER. A BLEED STREAM OF ABOUT 600 GPM IS PUMPED TO AN ASH SETTLING POND.

THE SCRUBBERS, SEPARATORS AND STUB STACKS ARE ALL STAINLESS STEEL. THE PIPING, RECIRCULATION PUMPS (3 AT 2400 GPM), AND ASH PUMPS (2 AT 500 GPM) ARE RUBBER LINED.

REFER TO FIGURE 14-22 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

GREAT SOUTHERN PAPER CO.; CEDAR SPRINGS, GEORGIA (CONTINUED)

OPERATING HISTORY

4TH QUARTER-1977 THE EXPANSION JOINT BETWEEN THE EXISTING STACK AND SCRUBBER HAD TO BE REPLACED IN SEPTEMBER. SOME INTERNAL WEAR WAS DETECTED ON THE PUMPS DUE TO ASH CONTENT. EROSION AND PLUGGING PROBLEMS WITH THE PH PROBES HAVE BEEN ENCOUNTERED. THE PLANT WAS IN PROCESS OF CHANGING THE CONTROL PH AND MOVING THE PROBES. TANKS AND NECESSARY EQUIPMENT TO CONTROL THE PROPER PH ARE EXPECTED TO BE COMPLETED IN A COUPLE OF MONTHS. OME EROSION WAS DETECTED IN THE RECIRCULATION LINES OF THE POWER BOILER SCRUBBER. THE LINES AND SOME OF THE VALVES HAD TO BE REPLACED.

1ST, 2ND, 3RD QUARTER-1978 GREATER PH CONTROL WAS ACHIEVED BY INSTALLING A CAUSTIC HOLD TANK AND REGULATING THE FLOW FROM THAT TANK TO MAINTAIN A CONSTANT PH IN THE RECIRCULATION TANK. THE RUBBER-LINED PIPING HAS ERODED AND IS GRADUALLY BEING REPLACED WITH STAINLESS STEEL. THE VENTURI SCRUBBER AND SEPARATOR WERE INSPECTED FOR CORROSION AND FOUND TO BE IN GOOD CONDITION.

4TH QUARTER-1978 PROBLEMS HAVE BEEN EXPERIENCED WITH PACKINGS IN ALL THE PUMPS. A MECHANICAL SEAL WAS TRIED AND LASTED 3 WEEKS. NEW SEALS WILL BE INSTALLED, AND SINCE THERE ARE BACK-UPS FOR ALL THE PUMPS IN THE SYSTEM, THIS SHOULD NOT CAUSE ANY DOWNTIME. PLANS FOR 1979 INCLUDE UPGRADING THE ASH HANDLING SYSTEM AND POSSIBLY INSTALLING A MIST ELIMINATOR IN THE TOP OF THE SEPARATOR. THE SOLIDS CONTENT IN THE RECIRCULATED LIQUOR WILL BE REDUCED BY INCREASING THE MAKE-UP WATER INPUT AND THE BLEED-OFF RATE AT THE RECIRCULATION TANK. ALSO, THE PRESENT BLEED LINE AND ASH PUMPS WILL BE REPLACED WITH A GRAVITY LINE.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GREAT WESTERN SUGAR
INSTALLATION LOCATION	BILLINGS, MONTANA
SOURCE CHARACTERISTICS	COAL (0.7% SULFUR)
SOURCE RATING	60,000 SCFM (TOTAL - 3 BOILERS)
NUMBER OF SEPARATE FGD UNITS	3
NUMBER OF BOILERS BEING CONTROLLED	3
CONTROL SYSTEM VENDOR	GREAT WESTERN SUGAR
CONTROL PROCESS	AMMONIA-LADEN PROCESS WATER
NEW / RETROFIT	RETROFIT
START-UP DATE	OCTOBER, 1977
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	35% (300-400 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO RIVER
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE FGD SYSTEM AT GREAT WESTERN SUGAR, BILLINGS, MONTANA PLANT HAS BEEN PRIMARILY DESIGNED FOR PARTICULATE CONTROL. HOWEVER, THE SCRUBBING LIQUOR CONTAINS ENOUGH NH3 (PH=8.7) TO OBTAIN A REMOVAL EFFICIENCY OF 35% FOR SO2. THE CONCENTRATION OF SO2 AT THE INLET IS 300-400 PPM. THE SYSTEM CONSISTS OF A VARIABLE THROAT VENTURI SCRUBBER AND A SINGLE STAGE, THREE PASS CHEVRON DEMISTER. THE SCRUBBER WAS INSTALLED IN OCTOBER, 1977 AND HAS BEEN OPERATING SATISFACTORILY.

THE SCRUBBER EFFLUENT IS BLED OFF TO A POND WHERE IT IS BLENDED AND COOLED WITH OTHER PROCESS WASTE STREAMS AND THEN PUMPED TO A RIVER.

OPERATING HISTORY

3RD QUARTER-1978	NO INFORMATION WAS REPORTED FOR THIS UPDATE PERIOD.

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GREAT WESTERN SUGAR
INSTALLATION LOCATION	FORT MORGAN, COLORADO
SOURCE CHARACTERISTICS	COAL (1.2% SULFUR, AVERAGE)
SOURCE RATING	65,230 SCFM (TOTAL - 2 BOILERS) 100,000 ACFM EACH @ 400 F (TOTAL - 2 BOILERS) 250,000 LBS/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	326 MM BTU/HR, 32 MW (EQUIVALENT): TOTAL - 2 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	GREAT WESTERN SUGAR
CONTROL PROCESS	AMMONIA-LADEN PROCESS WATER
NEW / RETROFIT	RETROFIT
START-UP DATE	OCTOBER, 1976
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	48% (300-400 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	95% (730 LBS/HR @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO RIVER
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE GREAT WESTERN SUGAR COMPANY HAS TWO COAL FIRED BOILERS AT THEIR FORT MORGAN, COLORADO PLANT. EACH BOILER IS RATED AT 125,000 LBS/HR OF STEAM; AND BURNS COAL WITH 0.54 PERCENT AVERAGE SULFUR, 8.7 PERCENT AVERAGE ASH, AND AN AVERAGE HEATING VALUE OF 10,176 BTU/LB. THE SUGAR FACTORY IS OPERATIONAL ONLY 3 MONTHS OF EVERY YEAR, DURING THE FALL QUARTER.

THE FGD SYSTEM WAS RETROFITTED IN OCTOBER 1976 AS A PROPRIETARY DESIGN PRIMARILY FOR PARTICULATE CONTROL. THE FLUE GASES FROM EACH BOILER (100,000 ACFM @ 400 F) PASS THROUGH MULTICLONES, AND THEN ARE SENT THROUGH A VENTURI SCRUBBER, WHICH OPERATES WITH A PRESSURE DROP OF 6 IN. W.G. AND L/G VALUE OF 8 GAL/1000 ACF. THE SCRUBBERS ARE FOLLOWED BY A COMMON VESSEL WHICH CONTAINS A SINGLE-STAGE, THREE-PASS CHEVRON MIST ELIMINATOR (M-E). WASH WATER FLOW TO THE M-E IS 120 GPM, WITH A FREQUENCY OF 15 MINUTES EVERY 8 HOURS. THE PRESSURE DROP ACROSS THE M-E IS 0.5 IN. W.G. A CONSTANT BLEED-OFF STREAM OF 800 GPM FROM EACH SCRUBBER IS SENT TO A POND, WHICH OVERFLOWS INTO ANOTHER HOLDING POND.

THE VENTURI SCRUBBER, THE PLUG, M-E VESSEL, AND THE M-E ARE ALL MADE OF 316L SS.

REFER TO FIGURE 14-25 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GREAT WESTERN SUGAR
INSTALLATION LOCATION	GERING, NEBRASKA
SOURCE CHARACTERISTICS	COAL (1.2% SULFUR, AVERAGE)
SOURCE RATING	110,000 SCFM (TOTAL - 2 BOILERS) 97,000 ACFM EACH @ 450 F (TOTAL - 2 BOILERS) 205,000 LBS/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	21 MW (EQUIVALENT); TOTAL - 2 BOILERS 218 MM BTU/HR (TOTAL) (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	GREAT WESTERN SUGAR
CONTROL PROCESS	AMMONIA-LADEN PROCESS WATER
NEW / RETROFIT	RETROFIT
START-UP DATE	OCTOBER, 1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	70% (600 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO RIVER EFFLUENT TO HOLDING POND
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE GREAT WESTERN SUGAR COMPANY HAS TWO COAL-FIRED BOILERS AT THEIR GERING, NEBRASKA PLANT. BOILER #1 IS RATED AT 150,000 LBS/HR OF STEAM AND WAS SUPPLIED BY ERIE CITY IN 1965. BOILER #2 IS RATED AT 55,000 LB/HR OF STEAM AND WAS SUPPLIED BY ERIE CITY IN 1954. THE COAL HAS 0.73 PERCENT AVERAGE SULFUR, 8.5 PERCENT AVERAGE ASH, AND AN AVERAGE HEATING VALUE OF 10,180 BTU/LB. THE SUGAR FACTORY IS OPERATIONAL ONLY 3 MONTHS OF EVERY YEAR, DURING THE FALL QUARTER.

THE FGD SYSTEM WAS RETROFITTED IN OCTOBER 1975 AS A PROPRIETARY DESIGN PRIMARILY FOR PARTICULATE CONTROL. THE FLUE GASES FROM TWO BOILERS (105,000 ACFM @ 31[illegible] F) PASS THROUGH CYCLONES, ARE MIXED IN A COMMON DUCT, AND THEN SENT THROUGH TWO VENTURI SCRUBBERS (EACH HEATING 97,000 ACFM @ 450 F), WHICH OPERATE WITH A PRESSURE DROP OF 6 IN. W.G. AND L/G VALUE OF 6.2 GAL/ACF. THE OPERATING GAS VELOCITY AT THE VENTURI INLET IS 43 FPS. THE SCRUBBERS ARE FOLLOWED BY A MIST ELIMINATOR (M-E) VESSEL WHICH CONTAINS A SINGLE-STAGE, THREE-PASS CHEVRON M-E. WASH WATER FLOW TO THE M-E IS 150 GPM, WITH A FREQUENCY OF 15 MINUTES EVERY 8 HOURS. THE PRESSURE DROP ACROSS THE M-E IS 0.5 IN. W.G. THE SCRUBBER EFFLUENT, 700 GPM FROM EACH SCRUBBER, IS SENT TO A POND.

THE VENTURI SCRUBBERS, VARIABLE DIAMETER PLUGS, M-E VESSEL, AND M-E ARE ALL MADE OF 304L SS. REFER TO FIGURE 14-27 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GREAT WESTERN SUGAR
INSTALLATION LOCATION	GREELEY, COLORADO
SOURCE CHARACTERISTICS	COAL (0.6% SULFUR)
SOURCE RATING	25,000 SCFM (1 BOILER)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	12 MW (EQUIVALENT) (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	GREAT WESTERN SUGAR
CONTROL PROCESS	AMMONIA-LADEN PROCESS WATER
NEW / RETROFIT	RETROFIT
START-UP DATE	OCTOBER, 1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	35% (300-400 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO RIVER
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

AT THE GREELY, COLORADO PLANT, GREAT WESTERN SUGAR HAS IN OPERATION 6 COAL FIRED BOILERS MANUFACTURED BY STERING AND PLACED IN SERVICE IN 1920. THE BOILERS OPERATE 2796 HOURS PER YEAR DURING THE FALL AND EARLY WINTER MONTHS. EACH BOILER POSSESSES THE FOLLOWING CHARACTERISTICS: AN OPERATING HEAT INPUT OF 29.7 MM BTU/HR, A DESIGN STEAM CAPACITY OF 12,225 LB/HR AND A DESIGN FLUE GAS FLOW RATE OF 28,333 ACFM @ 550 F. THE COAL USED AS FUEL HAS AN AVERAGE HEATING VALUE OF 9208 BTU/LB, AN AVERAGE SULFUR CONTENT OF 0.66% AND AN AVERAGE ASH CONTENT OF 5.39%.

THE SCRUBBER SYSTEM IS A WET VENTURI FOLLOWED BY A CHEVRON TYPE, ONE PASS MIST ELIMINATOR. THE MIST ELIMINATOR IS CONSTRUCTED OF 3/16" 316 STAINLESS STEEL AND THE SCRUBBER IS CONSTRUCTED OF 10 GA. 316L SS. DEMISTER WASH FLOW RATE IS 120 GPM. DESIGN FLUE GAS FLOW RATE IS 164,000 ACFM @ 550 F AND THE L/G RATIO IS 5.5 GAL/1000 CFM. THE FLOW OF SCRUBBING LIQUOR TO THE VENTURI IS 550 GPM. THE PRESSURE DROP ACROSS THE SCRUBBER IS 7" WG.

THE WASTE WATER FROM THE SCRUBBER IS AN ASH/WATER SLURRY WHICH IS CONTINUOUSLY DISCHARGED TO A POND AT 1100 GPM.

REFER TO FIGURE 14-28 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1978 NO INFORMATION WAS REPORTED FOR THIS REPORT PERIOD.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GREAT WESTERN SUGAR
INSTALLATION LOCATION	LOVELAND, COLORADO
SOURCE CHARACTERISTICS	COAL (1.2% SULFUR, AVERAGE)
SOURCE RATING	121,800 SCFM (TOTAL - 2 BOILERS) 100,000 ACFM EACH @ 410 F 100,000 LBS/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	61 MW (EQUIVALENT); TOTAL - 2 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	GREAT WESTERN SUGAR
CONTROL PROCESS	AMMONIA-LADEN PROCESS WATER
NEW / RETROFIT	RETROFIT
START-UP DATE	OCTOBER, 1973
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	30% (.95 LB/MM BTU @ INLET)
WATER MAKE-UP	800 GPM (PROCESS CONDENSATE WATER, PH=8.7, L/G=8)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO RIVER EFFLUENT STREAM TO HOLDING POND
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE GREAT WESTERN SUGAR COMPANY HAS TWO COAL-FIRED BOILERS AT THEIR LOVELAND, COLORADO PLANT. EACH BOILER IS RATED AT 125,000 LBS/HR OF STEAM AND BURNS COAL WITH 0.52 PERCENT AVERAGE SULFUR, 9.9 PERCENT AVERAGE ASH, AND AN AVERAGE HEATING VALUE OF 10,345 BTU/LB. THE SUGAR FACTORY IS OPERATIONAL ONLY 3 MONTHS OF EVERY YEAR, DURING THE FALL QUARTER.

THE FGD SYSTEM WAS RETROFITTED IN OCTOBER 1974 AS A PROPRIETARY DESIGN PRIMARILY FOR PARTICULATE CONTROL. THE FLUE GASES FROM EACH BOILER (100,000 ACFM @ 410 F) PASS THROUGH CYCLONES AND ARE MIXED IN A COMMON DUCT, AND THEN SENT THROUGH TWO VENTURI SCRUBBERS, WHICH OPERATE WITH A PRESSURE DROP OF 7 IN. W.G. AND L/G VALUE OF 7.5 GAL/1000 ACF. THE OPERATING GAS VELOCITY AT THE VENTURI INLET IS 43 FPS. THE SCRUBBERS ARE FOLLOWED BY A MIST ELIMINATOR (M-E) VESSEL WHICH CONTAINS A ONE-PASS, THREE-STAGE CHEVRON M-E. WASH WATER FLOW TO THE M-E IS 120 GPM, WITH A FREQUENCY OF 15 MINUTES EVERY 8 HOURS. THE PRESSURE DROP ACROSS THE M-E IS 0.5 IN. W.G. THE EFFLUENT STREAM FROM EACH SCRUBBER, 750 GPM, IS SENT TO A POND, WHICH OVERFLOWS INTO ANOTHER HOLDING POND.

THE VENTURI SCRUBBERS, VARIABLE DIAMETER PLUGS, M-E VESSEL, AND THE M-E ARE ALL MADE OF 316L SS.

REFER TO FIGURE 14-29 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GREAT WESTERN SUGAR
INSTALLATION LOCATION	SCOTTS BLUFF, NEBRASKA
SOURCE CHARACTERISTICS	COAL (1.2% SULFUR, AVERAGE)
SOURCE RATING	65,230 SCFM (TOTAL - 2 BOILERS) 130,000 ACFM EACH @ 400 F (TOTAL - 2 BOILERS) 300,000 LBS/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	32 MW (EQUIVALENT); TOTAL 2 - BOILERS 315 MM BTU/HR (TOTAL) (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	GREAT WESTERN SUGAR
CONTROL PROCESS	AMMONIA-LADEN PROCESS WATER
NEW / RETROFIT	RETROFIT
START-UP DATE	OCTOBER, 1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	35% (400 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	95%
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO RIVER EFFLUENT STREAM TO HOLDING POND.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE GREAT WESTERN SUGAR COMPANY HAS TWO COAL-FIRED BOILERS AT THEIR SCOTTS BLUFF, NEBRASKA PLANT. EACH BOILER IS RATED AT 150,000 LBS/HR OF STEAM AND BURNS COAL WITH 0.61 PERCENT AVERAGE SULFUR, 5.2 PERCENT AVERAGE ASH, AND AN AVERAGE HEATING VALUE OF 9,300 BTU/LB. THE SUGAR FACTORY IS OPERATIONAL ONLY 3 MONTHS OF EVERY YEAR, DURING THE FALL QUARTER.

THE FGD SYSTEM WAS RETROFITTED IN OCTOBER 1975 AS A PROPRIETARY DESIGN PRIMARILY FOR PARTICULATE CONTROL. THE FLUE GASES FROM TWO BOILERS (130,000 ACFM EACH @ 400 F) PASS THROUGH CYCLONES AND ARE MIXED, AND THEN SENT THROUGH TWO VENTURI SCRUBBERS, WHICH OPERATE WITH A PRESSURE DROP OF 6 IN. W.G. AND L/G VALUE OF 6.5 GAL/1000 ACF. THE OPERATING GAS VELOCITY AT THE VENTURI INLET IS 56 FPS. THE SCRUBBERS ARE FOLLOWED BY A DEMISTER VESSEL WHICH CONTAINS A SINGLE-STAGE, THREE-PASS CHEVRON MIST ELIMINATOR (M-E). WASH WATER FLOW TO THE M-E IS 150 GPM, WITH A FREQUENCY OF 10 MINUTES EVERY 8 HOURS. THE PRESSURE DROP ACROSS THE M-E IS 0.5 IN. W.G. THE SCRUBBER EFFLUENT, 825 GPM FROM EACH SCRUBBER, IS SENT TO A POND.

THE VENTURI SCRUBBERS, VARIABLE DIAMETER PLUGS, M-E VESSEL, AND THE M-E ARE ALL MADE OF 316L SS. REFER TO FIGURE 14-30 IN SECTION 14 FOR A DETAILED PROCESS FLOW OF THIS SYSTEM.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	ITT RAYONIER, INC.
INSTALLATION LOCATION	FERNANDINA BEACH, FLORIDA
SOURCE CHARACTERISTICS	BARK,OIL (2.0% - 2.5% SULFUR)
SOURCE RATING	176,000 SCFM (TOTAL - 4 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	4
SOURCE CAPACITY	88 MW (EQUIVALENT); TOTAL - 4 BOILERS
	(FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	AIRPOL INDUSTRIES
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	80% - 85% (1,200 PPM AT INLET)
PARTICULATE REMOVAL EFFICIENCY	97% (1.7 GR/SCF AT INLET)
WATER MAKE-UP	OPEN LOOP
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO TAILINGS POND
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

ITT RAYONIER OPERATES AN AMMONIA-BASED SULFITE PULP MILL IN FERNANDINA BEACH, FLORIDA. THERE ARE FOUR PROCESS STEAM BOILERS TYPICALLY OPERATING AT APPROXIMATELY 80 TO 90% LOAD. TWO ARE RATED AT 125,000 LB/HR STEAM, ONE AT 100,000 LB/HR STEAM AND ONE AT 150,000 LB/HR STEAM. ALL ARE RATED AT 600 PSIG. THE FOUR BOILERS OPERATE IN THE FOLLOWING MANNER:

NO. 1 - 100,000 LB/HR STEAM - FIRES FUEL OIL (NO. 6)
NO. 2 - 125,000 LB/HR STEAM - FIRES A COMBINATION OF BARK AND NO. 6 FUEL OIL
NO. 3 - SAME AS NO. 2
NO. 4 - 150,000 LB/HR STEAM - FIRES FUEL OIL (NO. 6)

FLUE GASES LEAVING THE NUMBER TWO AND THREE BOILERS ENTER INTO SEPARATE MECHANICAL COLLECTORS (BUELL CYCLONE COLLECTORS) FOR PARTICULATE REMOVAL OF ABOUT 97% (1.7 GR/SCF @ INLET). TWO IDENTICAL FGD SYSTEMS ARE USED TO REMOVE 80 TO 85 PERCENT OF THE SO2 FROM THE GAS FROM ALL FOUR BOILERS. BOILERS ONE AND TWO ARE MANIFOLDED INTO ONE SCRUBBER SYSTEM DESIGNED FOR 165,000 ACFM AT 460 F WHILE GASES FROM THREE AND FOUR ARE MANIFOLDED INTO THE SECOND SCRUBBER SYSTEM DESIGNED FOR 140,000 ACFM AT 460 F. EACH SYSTEM USES A VARIABLE-THROAT VENTURI SCRUBBER FOR SO2 REMOVAL WHICH IS PRECEDED BY AN I.D. FAN. THE PRESSURE DROP ACROSS THE VENTURI VARIES BETWEEN 15 AND 22 INCHES WG. A 10% CAUSTIC SOLUTION IS INJECTED AT THE THROAT OF THE VENTURI BY A 75 HP PUMP(FULL LOAD). THE CAUSTIC IS EITHER OBTAINED FROM THE MIDDLE STAGE OF THEIR PULP BLEACHING OPERATION OR PURCHASED. USUALLY PUR-

ITT RAYONIER, INC.; FERNANDINA BEACH, FLORIDA (CONTINUED)

CHASED CAUSTIC IS USED AND THE CAUSTIC FROM THE BLEACHING OPERATION IS SOLD TO KRAFT MILLS. CONTROL PH IS IN THE RANGE OF 5.5 TO 6.0. THE LIQUID-GAS MIXTURE ENTERS A SEPARATOR (38 FT HIGH X 16.5 FT DIA.) WHICH INCORPORATES SPIN VANES FOR LIQUID SEPARATION. THE LIQUID DROPS TO THE BOTTOM OF THE SEPARATOR INTO THE RECIRCULATION TANK. THE GASES LEAVE THE TOP OF THE SEPARATOR AND LEAD DIRECTLY TO THE STACK, EXITING AT A TEMPERATURE OF APPROXIMATELY 135 F.

THE VENTURIS, SEPARATORS (INCLUDING SPIN VANES), SPENT LIQUOR PIPING AND HOLD TANKS ARE ALL CONSTRUCTED OF 316L SS.

REFER TO FIGURE 14-31 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

4TH QUARTER-1977 PLANT REPORTED THAT BOILERS NO. 2 AND 3 WERE OPERATING AT REDUCED LOADS, EACH IN THE RANGE OF 75,000 - 90,000 LBS/HR STEAM. THE SPENT CAUSTIC WAS NOT BEING USED FOR SCRUBBING LIQUOR. ITT WAS SELLING THE SPENT CAUSTIC TO KRAFT MILLS WHO USE IT FOR THEIR SODA BASE. CONDENSATE STEAM WAS BEING RECYCLED AND USED FOR SCRUBBING PURPOSES. SOME EROSION HAS BEEN NOTED AT THE VENTURI THROAT.

2ND QUARTER-1978 THE PLANT WAS STILL UTILIZING CONDENSATE WATER FOR SCRUBBER LIQUOR. APPROXIMATELY 3 TONS PER DAY OF SODIUM HYDROXIDE WAS BEING USED TO MAINTAIN PH. THE ORIGINAL HOT WASTE STREAM CAUSTIC WAS NOT USED FOR SCRUBBER PURPOSES, DUE TO PROCESS-RELATED PROBLEMS THAT OCCURRED. SCRUBBER EFFLUENT WAS STILL BEING SOLD TO KRAFT MILLS. THE SYSTEM HAS TWO SCRUBBERS, 'A' AND 'B'. A-MODULE WAS DOWN 4 WEEKS IN JUNE AND JULY BECAUSE OF AN F.D. FAN FAILURE, BELIEVED TO BE A RESULT OF POORLY OPERATED MECHANICAL COLLECTORS. NEW MECHANICALS WERE BEING INSTALLED TO PREVENT FURTHER ABRASION. THE PLANT REPORTED THAT SINCE JANUARY, SCRUBBER OPERABILITY HAD BEEN APPROXIMATELY 95%.

3RD QUARTER-1978 THE BOILER AND FGD SYSTEM OPERATED APPROXIMATELY 95% OF THE PERIOD. THE ONLY OUTAGE DURING THE PERIOD WAS BOILER-RELATED AND LASTED THREE DAYS. THE BEARINGS IN THE I.D. FAN HAD TO BE REPLACED.

4TH QUARTER-1978 THE FGD SYSTEM DEMONSTRATED AN ESTIMATED 95% RELIABILITY. A CRACKED FAN FOUNDATION ON MODULE A CAUSED THAT MODULE TO BE NON-OPERABLE FOR 10 DAYS. I-BEAMS WERE PLACED UNDER THE FOUNDATION TO RESTORE SUPPORT. AT THE SAME TIME, NEW SEALS WERE PLACED IN THE DUST COLLECTOR TO SLOW DOWN THE SEVERE EROSION PROBLEMS ON THE FAN. THE FAN SHROUD HAS BEEN REBUILT SEVERAL TIMES; THIS IS THE SECOND FAN. THE PLANT PLANS TO INSTALL NEW DUST COLLECTORS SOMETIME IN APRIL. UNTIL THEN, INTERMITTENT DOWNTIME IS EXPECTED.

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	KERR-MCGEE CHEMICAL CORP.
INSTALLATION LOCATION	TRONA, CALIFORNIA
SOURCE CHARACTERISTICS	COKE/COAL/OIL (0.5% - 5.0% SULFUR)
SOURCE RATING	490,000 SCFM (TOTAL - 2 BOILERS) 726,000 ACFM @ 320 F (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	245 MW (64 MW ELECTRIC POWER, AND THE BALANCE IS PROCESS STEAM) TOTAL - 2 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	COMBUSTION EQUIPMENT ASSOC.
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	JUNE, 1978
CONTROL SYSTEM STATUS	OPERATIONAL
SO_2 REMOVAL EFFICIENCY	98+% (AT MAXIMUM LOADING)
PARTICULATE REMOVAL EFFICIENCY	98.5% (COLLECTED BY PRECEDING ESP'S)
WATER MAKE-UP	OPEN LOOP; 125 GPM BURKITE SCRUBBING LIQUOR (47% NA_2CO_3 AND 41% NA_2SO_4)
SLUDGE OR BY-PRODUCT DISPOSAL	HOLDING POND FOR EVAPORATION SCRUBBER EFFLUENT IS CLARIFIED AND THEN PUT INTO A MINERAL DEPOSIT.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

KERR-MCGEE CHEMICAL CORP. HAS A NEW 1.3 MM TON/YR SODA ASH PLANT AT TRONA, CALIFORNIA. THE PLANT, LOCATED ALONG THE SHORE OF SEARLES LAKE, IS THE LARGEST YET BUILT TO YIELD SODA ASH BY DIRECT CARBONATION OF BRINE AND WAS COMMISSIONED IN JUNE 1978. THE PROCESSING INNOVATIONS, WHICH HAVE IMPROVED THE PLANT EFFICIENCY, INCLUDE CARBONATION UNDER 13.5 PSI PRESSURE, USE OF A COAL-FIRED POWER PLANT, AND RECOVERY OF CO_2 FROM THE FLUE GASES.

THE PLANT HAS TWO BOILERS, EACH PRODUCING 600,000 LB/HR STEAM AT 1500 PSI. THE STEAM IS INITIALLY USED TO DRIVE TWO 32 MW NON-CONDENSING STEAM TURBINES FOR ELECTRIC POWER, THEN IS USED AS PROCESS STEAM. THE TOTAL MW EQUIVALENT IS ABOUT 245 MW. EACH BOILER BURNS A MIXTURE OF WESTERN COAL (0.7 PERCENT SULFUR) AND PETROLEUM COKE (5.5 PERCENT SULFUR). THE HIGH SULFUR COKE IS MIXED WITH THE COAL IN ORDER TO IMPROVE THE PARTIAL IONIZATION AND THEREFORE IMPROVE FLY-ASH COLLECTION IN THE ESP WHICH OPERATES ON THE COLD SIDE OF THE PREHEATER AT 98.5 PERCENT EFFICIENCY AND 300 F. THE FLUE GAS FLOW RATE FROM EACH BOILER IS 363,000 ACFM AT 320 F AND MAY CONTAIN SO_2 BETWEEN 335 TO 5985 PPM

KERR-MCGEE CHEMICAL CORP.: TRONA, CALIFORNIA (CONTINUED)

DEPENDING UPON THE FUEL. THE AIR POLLUTION REGULATIONS DICTATE THAT EACH BOILER MAY RELEASE NOT MORE THAN 10 LBS/HR PARTICULATE, 200 LBS/HR OF SO_2 AND 140 LBS/HR OF NOX.

THE FLUE GASES ARE SCRUBBED BY THE END LIQUOR FROM THE SODA ASH PLANT IN TWO SCRUBBERS (30 FT DIA X 35 FT HIGH EACH) WHICH ARE MILD STEEL VESSELS WITH FLAKE LINING AND THREE 317L SS SIEVE TRAYS. THE TOP TRAY RECEIVES PLAIN WATER WHEREAS THE SECOND TRAY RECEIVES THE RECIRCULATING LIQUOR AT PH OF 6 - 6.5. THE SPENT LIQUOR FROM THE BOTTOM OF THE SCRUBBERS IS RECIRCULATED BY RUBBER LINED PUMPS, FRESH END-LIQUOR IS ADDED DIRECTLY TO THE RECIRCULATION LINE. A BLEED OFF STREAM IS CONTINUOUSLY TAKEN BACK TO THE SALT PONDS.

THE BOILER I.D. FANS (1600 HP) FORCE THE GASES THROUGH THE SCRUBBERS AND EXPERIENCE 6 IN. WG PRESSURE DROP. THE FANS HAVE MILD STEEL CASINGS. THE DOWNSTREAM DUCTWORK IS MILD STEEL WITH FLAKE LINING WHEREAS THE STACK IS CONCRETE WITH FRP LINER. AMBIENT AIR IS HEATED IN AN EXTERNAL STEAM HEATER AND MIXED WITH THE EXIT FLUE GASES TO INCREASE THE TEMPERATURE FROM 125 F TO ABOUT 175 F. AT MAXIMUM LOADING, THE SCRUBBERS HAVE A SO_2 REMOVAL EFFICIENCY OF 98 PERCENT. THE SCRUBBED FLUE GASES ARE PROCESSED THROUGH TWO MONOETHANOLAMINE (MEA) PLANTS FOR EXTRACTION OF CO_2. EACH MEA PLANT WILL PRODUCE 300 TONS/DAY OF CO_2 AND WILL BE THE MAIN SOURCE OF MAKEUP CO_2 FOR THE CARBONATION STEP.

REFER TO FIGURE 14-32 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

1ST QUARTER-1978 THE MAJOR CONSTRUCTION WORK WAS OVER. PRECOMMISSIONING ACTIVITIES WERE UNDERWAY. THE PLANT WAS PROJECTED TO GO ONSTREAM BY APRIL 1, 1978.

2ND QUARTER-1978 THE FGD SYSTEM WAS COMMISSIONED DURING THE REPORT PERIOD. THE BOILERS WERE RUN TO FULL CAPACITY WITH 100% OIL FEED. COAL AND COKE WERE USED UP TO 80% AS THE FUEL. THE MAJOR STARTUP PROBLEM WAS TRAY TIEDOWN. THE POLYPROPYLENE SIEVE TRAYS WERE NOT STRONG ENOUGH TO TAKE THE LOAD OF INVENTORY LIQUID. THESE WILL BE REPLACED BY 316L SS OR A HIGHER GRADE ALLOY. THE PRESENCE OF CHROMATE IONS IN THE MAKEUP WATER CAUSED SOME CONCERN.

3RD QUARTER-1978 THERE WERE ONLY 2 BOILER AND FGD OUTAGES DURING THE PERIOD. BOTH OUTAGES WERE FOR REPLACING THE SIEVE TRAYS IN THE ABSORBER MODULES. TRAYS WERE REPLACED BY 317L SS: IN THE FIRST MODULE DURING A 5-DAY OUTAGE IN AUGUST, AND IN THE SECOND DURING A 4-DAY OUTAGE IN SEPTEMBER. COAL AND COKE WERE USED FOR 90 TO 95 PERCENT AS THE FUEL. OIL WAS NOT USED AT ALL, WHILE GAS WAS AVAILABLE ONLY AS A BACK-UP.

4TH QUARTER-1978 THE 317L SS TRAYS ARE WORKING QUITE WELL. THE PROBLEM WITH THE POLYPROPYLENE SIEVE TRAYS WAS NOT THAT THEY WERE NOT STRONG ENOUGH TO SUPPORT THE LOAD OF INVENTORY

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

KERR-MCGEE CHEMICAL CORP.; TRONA, CALIFORNIA (CONTINUED)

LIQUID AS REPORTED IN THE 2ND QUARTER 1978, BUT INSTEAD WAS A PROBLEM WITH TRAY TIEDOWN. THE HOLES PUNCHED IN THE TRAYS WERE UNDERSIZED AND THE PUNCHING WAS NOT CLEAN CUT; RAGGED LOOSE FIBERS WERE LEFT AROUND THE PERIMETER OF THE HOLE. THIS QUARTER, THE BOILERS BURNED A MIXTURE OF COAL AND COKE. THE COAL WAS RATED AT 10,000 BTU/LB AND 0.5% SULFUR. THE COKE WAS RATED AT 13,100 BTU/LB AND 3.5% SULFUR. A NET SULFUR CONTENT OF 1.5% IS DESIRED. ONE BOILER WAS DOWN FOR 30 DAYS, BUT WAS NOT A RESULT OF SCRUBBER PROBLEMS. BOTH SCRUBBERS DEMONSTRATED 100% RELIABILITY.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	MEAD PAPERBOARD CO.
INSTALLATION LOCATION	STEVENSON, ALABAMA
SOURCE CHARACTERISTICS	OIL (1.5% - 3% SULFUR)
SOURCE RATING	100,000 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	50 MW (EQUIVALENT); TOTAL - 2 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	AIRPOL INDUSTRIES
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	95% (1,500 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	90%
SLUDGE OR BY-PRODUCT DISPOSAL	ALKALINE SULFITE/BISULFITE RECYCLED TO PULP PROCESS RECOVERED SOLUTION USED AS MAKE-UP TO COOKING LIQUOR IN PULP MILL.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE MEAD PAPERBOARD COMPANY IN STEVENSON, ALABAMA, IS A NEUTRAL SULFITE PULP MILL WITH A 500 TON/DAY PULP PRODUCTION RATE. THE MILL HAS A CHEMICAL RECOVERY SYSTEM THAT ABSORBS SO2 FROM THE BILLERUD REACTOR. EFFLUENT FROM THE RECOVERY SYSTEM FLOWS BACK TO THE PULPING OPERATION.

ELSEWHERE ON-SITE, AN AIRPOL INDUSTRIES ABSORBER TOWER CONTROLS PARTICULATE AND SO2 EMISSIONS FROM TWO OIL-FIRED (1.5% - 3.0% SULFUR) COMBUSTION-ENGINEERING PACKAGE BOILERS EACH PRODUCING 175,000 LB/HR STEAM AT 600 PSI. THE BOILERS ARE TYPICALLY OPERATED AT 80% OF MAXIMUM LOAD. FLUE GAS VOLUME INTO THE SCRUBBER IS 173,000 ACFM @ 450 F. HOT GASES PASS THROUGH A STAINLESS STEEL VENTURI/QUENCH SECTION FOR COOLING AND INITIAL SO2 REMOVAL. THE FLUE GAS THEN ENTERS THE BOTTOM OF THE ABSORBER SECTION AND PASSES UP THROUGH THREE BUBBLE-CAP TRAYS. A SODIUM CARBONATE SOLUTION IS INTRODUCED THROUGH A BANK OF EIGHT, 1.5-INCH NOZZLES CONSTRUCTED OF 316L SS AND SPIN VANES. THE SOLUTION IS ADDED TO THE RECIRCULATION LINE ON THE SUCTION SIDE OF THE RECIRCULATION PUMP AT A RATE OF 20-25 GPM. SCRUBBER EFFLUENT, MOSTLY SODIUM SULFITE, IS SENT TO THE MILLS PULPING OPERATIONS BY A CONTINUOUS BLEED-OFF LINE AT 30-35 GPM FOR EVENTUAL USE IN THE DIGESTERS.

MILL WATER IS ADDED TO THE RECIRCULATION TANKS WHEN NEEDED TO COVER EVAPORATION LOSSES. IT IS NOT A CONTINUOUS FLOW. EVAPORATION LOSSES ARE ESTIMATED TO BE APPROXIMATELY 100 GPM. THE RECIRCULATION RATE TO THE VENTURI IS APPROXIMATELY 2000 GPM AND THE RECIRCULATION RATE TO THE ABSORBER IS

ABOUT 1200 GPM. THE GAS EXITS THROUGH A FIBERGLASS STACK AT APPROXIMATELY 140 F.

THE PH MONITORING SYSTEM CONSISTS OF A FIBERGLASS BOX MOUNTED ON THE RECIRCULATION TANK. OVERFLOW FROM THE TANK TO THE BOX INSURES CONTINUOUS FLOW.

OPERATING HISTORY

EARLY OPERATIONS

THE SO2 SCRUBBING SYSTEM WAS DOWN FROM MARCH THROUGH JULY 1976 DUE TO ABRASION PROBLEMS. THE ABRASION WAS CAUSED PARTIALLY BY HIGH STREAM VELOCITY THROUGH THE EXISTENT VENTURI PARTICULATE SCRUBBER INTO THE SO2 SCRUBBER. SODIUM CARBONATE AND CARBON PARTICLES THAT HAD NOT GONE INTO SOLUTION ALSO WERE VERY ABRASIVE TO THE SO2 SCRUBBER LINING. IN ADDITION, THE ORIGINAL GLASS-FLAKED LINER (5 MM THICK) WAS EXPERIENCING STRESS CRACKING.

THE HIGH VELOCITIES INTRODUCED BY THE VENTURI WERE ELIMINATED BY REMOVING THE PARTICULATE VENTURI SECTION OF THE SYSTEM. THE GLASS-FLAKED LINING WAS PATCHED WITH $60,000 WORTH OF CARPENTER 20 LINER. THESE CORRECTIVE ACTIONS HELPED FOR A WHILE, BUT AS IT TURNED OUT, THE CARPENTER 20 WAS NOT INSTALLED PROPERLY AND SOLUTION WAS GETTING BETWEEN IT AND THE MILD STEEL SHELL. IT WAS FINALLY DECIDED TO INSTALL NEW RUBBER LINING INSIDE THE ENTIRE SCRUBBER, INCLUDING THE SPIN VANES, AT A COST OF $150,000. TO PREVENT ANY HEAT PROBLEMS, ADDITIONAL NOZZLES WERE INSTALLED. TO DATE, NO MAJOR PROBLEMS HAVE OCCURRED WITH THE RUBBER LINING.

SCRUBBER MAINTENANCE IS PERFORMED WHENEVER MILL OPERATIONS CEASE FOR ROUTINE PLANT MAINTENANCE WHICH OCCURS SEVERAL TIMES PER YEAR. THE PH CONTROL SYSTEM RECEIVES CONTINUING MAINTENANCE AND THE PH PROBES ARE CLEANED ONCE PER WEEK.

REFER TO FIGURE 14-33 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

4TH QUARTER-1977   MINOR EMBRITTLEMENT, DUE TO LOCALIZED HIGH TEMPERATURE, HAS BEEN DETECTED ON THE LINING SURFACE. SOME METAL, NOZZLES, AND RUBBER HVAVE BEEN REPLACED.

2ND QUARTER-1978   THE PLANT WAS DOWN 12 DAYS IN JUNE FOR A MAJOR PAPER MACHINE UPDATE, AND THE BOILERS WERE DOWN 9 DAYS DURING THAT PERIOD. DURING BOILER DOWNTIME, THE RUBBER LINERS IN THE ABSORBER MODULE WERE REPAIRED AND MODIFICATIONS WERE MADE AT THE INLET TO THE ABSORBER, REDIRECTING AIR FLOW TO MINIMIZE FURTHER FLYASH ABRASION OF THE LINERS. THE PLANT REPORTED AN OPERABILITY OF 100% FOR THE FGD SYSTEM.

3RD QUARTER-1978   AN AVAILABILITY OF 100% WAS REPORTED FOR THE FGD SYSTEM DURING THIS PERIOD.

4TH QUARTER-1978   THE RUBBER LINER IN THE ABSORBER AND THE DEFLECTOR SHIELD AT THE INLET OF THE

MEAD PAPERBOARD CO.; STEVENSON, ALABAMA (CONTINUED)

ABSORBER ARE HOLDING WELL. THE PLANT HAS REPORTED 100% RELIABILITY FOR THE SCRUBBER. ONE OF THE BOILERS WAS DOWN FOR 24 HOURS AND THE OTHER WAS DOWN FOR 48 HOURS IN NOVEMBER FOR THE REPLACEMENT OF SEALS AND PREHEATERS. THE SCRUBBER WAS CHECKED AT THIS TIME. NORMALLY THE SCRUBBER IS INSPECTED NO MORE THAN TWICE A YEAR AND THESE INSPECTIONS ARE DURING SCHEDULED MILL SHUTDOWNS. FOUR NOZZLES IN THE ABSORBER WERE REPLACED ON DECEMBER 1ST, WITHOUT ANY DOWNTIME.

THE PLANT IS CONSIDERING CHANGING THE PH CONTROLLED MAKE-UP LIQUOR FEED TO A FLOW CONTROLLED FEED BECAUSE THE PH PROBES ARE HARD TO KEEP CALIBRATED AND ARE UNRELIABLE.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	MINN-DAK FARMER'S CO-OPERATIVE
INSTALLATION LOCATION	WAHPETON, NORTH DAKOTA
SOURCE CHARACTERISTICS	LIGNITE (1.0% SULFUR)
SOURCE RATING	164,000 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	82 MW (EQUIVALENT); TOTAL - 2 BOILERS TWO BOILERS, EACH @ 275,000 LBS/HR STEAM (250 PSIG - 455 F) (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	KOCH ENGINEERING
CONTROL PROCESS	AMMONIA SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	JUNE, 1977
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	TESTS INCONCLUSIVE.
WATER MAKE-UP	200 GPM AMMONIACAL WASTE STREAM
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT BLEED STREAM GOES TO AN ACTIVATED SLUDGE SYSTEM @ 160 GPM ANAEROBIC DIGESTION, FOLLOWED BY AN OPEN POND, FOLLOWED BY AEROBIC DIGESTION.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

MINN-DAK FARMER'S CO-OP. HAS A SUGAR FACTORY AT WAHPETON, NORTH DAKOTA. THERE ARE TWO BOILERS, EACH WITH A CAPACITY OF 275,000 LBS STEAM/HR AT 250 PSIG AND 455 F. EACH BOILER GENERATES 125,000 ACFM OF FLUE GAS AT 350 F. THE FUEL BURNED IS 1% SULFUR LIGNITE. SULFUR DIOXIDE REMOVAL IS EFFECTED BY AN AMMONIA WASTE STREAM FROM AN ON-SITE PROCESS ADDED TO THE RECIRCULATING SCRUBBER LIQUOR.

KOCH ENGINEERING HAS SUPPLIED TWO VARIABLE THROAT VENTURI SCRUBBERS WITH OPEN ENDED PIPE INLETS FOR SCRUBBING LIQUOR. THE SYSTEM WAS PRIMARILY DESIGNED FOR PARTICULATE CONTROL. INLET CONCENTRATIONS OF SO2 AND PARTICULATE ARE 76-193 LB/HR AND .3-.4 GR/SCF RESPECTIVELY. OUTLET CONCENTRATIONS OF SO2 AND PARTICULATE ARE 10-37 LB/HR AND .027-.058 GR/SCF RESPECTIVELY. THE GAS FROM EACH VENTURI IS ROUTED THROUGH A CHEVRON-TYPE MIST ELIMINATOR AND ONE 7 FOOT X 130 FOOT STACK. THE PRESSURE DROP ACROSS EACH SCRUBBER IS 11 INCHES W.G. THE SCRUBBER LIQUOR IS RECIRCULATED AT A RATE OF 2000 GPM FROM A CONCRETE TAR-LINED RECIRCULATION PIT APPROXIMATELY 10 FT X 10 FT X 10 FT. THE RECIRCULATION PUMP IS RATED AT 75 HP AND 3000 GPM. ANOTHER PUMP IS KEPT ON STANDBY. SCRUBBER BLOWDOWN IS 486 GPM TO AN AEROBIC DIGESTER. AFTER THE DIGESTER THE WASTE STREAM GOES TO AN OPEN POND, THEN AN AEROBIC DIGESTER, THEN AGAIN TO A POND.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

MINN-DAK FARMER'S CO-OPERATIVE; WAHPETON, NORTH DAKOTA (CONTINUED)

THERE ARE A TOTAL OF FIVE PONDS ON SITE, FOUR WASTEWATER AND ONE MAIN RESERVOIR. THE FOUR WASTEWATER PONDS ARE USED INTERCHANGEABLY FOR MAKE-UP AND WASTE DISPOSAL. MAKE-UP TO THE RECIRCULATION TANK IS 500 GPM WHERE PH IS MAINTAINED AT APPROXIMATELY 5.4. WHEN ADDITIONAL MAKE-UP IS REQUIRED, IT IS OBTAINED FROM THE BAROMETRIC CONDENSORS. THE BAROMETRIC CONDENSER WATER IS THE MAKE-UP WATER THAT CONTAINS THE AMMONIACAL WASTE WASTE WHICH REMOVES SO2. THIS MAKE-UP IS NOT A CONTINUOUS FLOW.

DEMISTER WASH WATER IS ALSO BAROMETRIC CONDENSOR WATER AND IS A 250 GPM SPRAY EVERY 8 HOURS. THE PUMPS USED FOR PUMPING MAKE-UP FROM THE PONDS AND SCRUBBER BLOWDOWN ARE LOCATED IN A CENTRAL PUMPHOUSE. THERE ARE SEVERAL PUMPS WHICH ARE USED INTERCHANGEABLY. 80 GPM WATER LOSS TO THE ATMOSPHERE THROUGH THE STACK HAS BEEN CALCULATED, BUT NEVER MEASURED.

THE SCRUBBERS AND THE LIQUOR INLET PIPES ARE MADE OF 316L SS, THE DEMISTER AND STACK ARE 316 SS, AND THE RECIRCULATING PIPING IS FIBERGLASS. THE TOTAL PURCHASE COST OF THE EQUIPMENT WAS $300,000 IN 1977 DOLLARS. INITIALLY THE SYSTEM WAS DESIGNED TO USE A LIME SLURRY OF PH 10.0 AS THE SCRUBBING LIQUOR. HOWEVER, DURING THE FIRST SIX WEEKS OF OPERATION, NUMEROUS PLUGGING AND SCALING PROBLEMS OCCURRED. HENCE, PLANT PERSONNEL BEGAN USING THE AMMONIA-RICH WASTE STREAM FROM ANOTHER ON-SITE PROCESS IN EARLY 1978.

EACH YEAR, THE PLANT ONLY OPERATES FROM SEPTEMBER - FEBRUARY. THIS IS THE BEET SUGAR PRODUCTION PERIOD. DURING THE REMAINDER OF THE YEAR, PRODUCTION DISTRIBUTION IS THE MAIN PLANT ACTIVITY.

REFER TO FIGURE 14-34 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1978 THE FGD SYSTEM BEGAN OPERATIONS FOR THE 1978-1979 SEASON ON SEPTEMBER 12. NO FGD-RELATED PROBLEMS OCCURRED. THE WASTE TREATMENT HAS BEEN MODIFIED TO INCLUDE AN ANAEROBIC DIGESTER FOLLOWED BY AN OPEN POND AND AN AEROBIC DIGESTER.

4TH QUARTER-1978 EXCESSIVE HEAT LOSS WAS A PROBLEM FOR THE DIGESTERS. THEY ARE CURRENTLY ONLY PARTIALLY ENCLOSED. PLANS ARE BEING MADE TO ENCLOSE MORE OF THE WASTE TREATMENT FACILITIES. OTHERWISE, THE FGD SYSTEM PERFORMED WELL FOR THE QUARTER. PLANT PERSONNEL FEEL MOST OF THEIR INITIAL PROBLEMS HAVE BEEN SOLVED.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	MOBIL OIL COMPANY
INSTALLATION LOCATION	SAN ARDO, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (2.0% - 2.25% SULFUR)
SOURCE RATING	175,000 SCFM (TOTAL - 28 BOILERS)
NUMBER OF SEPARATE FGD UNITS	28
NUMBER OF BOILERS BEING CONTROLLED	28
SOURCE CAPACITY	91 MW (EQUIVALENT); 800 MM BTU/HR: TOTAL - 28 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	IN-HOUSE DESIGN
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	1974
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90% (1500 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	HOLDING POND FOR EVAPORATION
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE MOBIL OIL COMPANY HAS AN OIL SITE IN SAN ARDO, CALIFORNIA WHERE 28 STEAM GENERATORS ARE USED TO FORCE OIL OUT OF WELLS BY A DEEP WELL STEAM INJECTION PROCESS. THE FUEL USED IS CRUDE OIL WITH 2 - 2.5% SULFUR. EACH STEAM GENERATOR IS FOLLOWED BY AN INDIVIDUAL FGD SYSTEM DESIGNED BY IN-HOUSE ENGINEERING. THE UNITS EXPERIENCED STARTUP IN THE PERIOD FROM 1973 THROUGH 1974.

THERE ARE TWO SIZES OF STEAM GENERATORS: 22MM BTU/HR (20 UNITS) AND 50MM BTU/HR (8 UNITS). THE SMALL UNITS GENERATE 8,000 ACFM, AND THE LARGE UNITS 18,000 ACFM. THE GASES ARE SCRUBBED BY A LIQUOR CONSISTING OF NAOH AND ALKALINE OIL FIELD WASTEWATER (NA2CO3). THE PROCESS IS ONCE-THROUGH AND PH VALUES OF 8.0 AND 6.0 ARE MAINTAINED AT THE INLET AND OUTLET OF THE SCRUBBERS, RESPECTIVELY. THE SPENT LIQUOR FROM THE BOTTOM OF THE SCRUBBERS IS DISPOSED OF IN THE WASTEWATER DISPOSAL ZONE. THERE IS NO RECYCLE FROM THE DISPOSAL ZONE. THE LIQUOR FLOW RATES TO THE TWO SIZES OF THE SCRUBBERS ARE 75 GPM AND 200 GPM. THE SCRUBBER SIZES ARE 4 FT DIAMETER X 20 FT HIGH, AND 6.5 FT DIAMETER X 25 FT HIGH. EACH SCRUBBER HAS THREE V-GRATE TYPE TRAYS. THE I.D. FANS ON EACH SCRUBBER EXPERIENCE 3 - 4 IN. W.G. PRESSURE DROP. THE SO2 REMOVAL EFFICIENCY OF THE PROCESS IS 90 PERCENT WITH AN INLET CONCENTRATION OF 1500 PPM. CHEVRON-TYPE MIST ELIMINATORS ARE USED.

THE SCRUBBERS ARE 316L SS AND THE TRAYS 316 SS. THE INLET DUCTWORK IS CARBON STEEL UP TO THE ECONOMIZER AND THEN 316L SS. THE DOWNSTREAM DUCT IS FIBERGLASS AND THE I.D. FANS ARE CARBON STEEL WITH 316L SS LINING ON THE CASING. THE STACK IS FIBERGLASS. THE FLUE GASES ARE NOT REHEATED AND

MOBIL OIL COMPANY: SAN ARDO, CALIFORNIA (CONTINUED)

CANNOT BE BYPASSED. THE MIST ELIMINATORS, ORIGINALLY 316L SS, HAVE BEEN LINED WITH PHENOLIC EPOXY RESIN TO COMBAT CORROSION.

REFER TO FIGURE 14-36 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

INADEQUATE MIST REMOVAL HAS RESULTED IN CORROSION OF THE I.D. FAN IMPELLER, BLADES, AND HUBS, WHICH NEED REPLACEMENT EVERY YEAR. THE HIGH CLORIDE CONTENT IN THE WASTEWATER IS THE PRIMARY CAUSE OF PITTING OF SS MATERIAL.

3RD QUARTER-1978 FOR THIS PERIOD, THERE WAS NO MAJOR DOWNTIME REPORTED AS A RESULT OF EQUIPMENT OR PROCESS FAILURE. RELIABILITY WAS ESTIMATED AT ABOUT 90%. A BECKMAN PH CONTROL UNIT WAS INSTALLED ON A SCRUBBING UNIT WITH PLANS TO ADD MORE CONTROLLERS.

4TH QUARTER-1978 THE I.D. FANS ARE ALSO LINED WITH EPOXY RESIN TO REDUCE CORROSION. THE BECKMAN PH CONTROLLER HAS PERFORMED WELL AND SEVERAL MORE OF THESE DEVICES HAVE BEEN INSTALLED. THE AVERAGE AVAILABILITY OF AN FGD SYSTEM WAS ABOUT 95 PERCENT.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	NEKOOSA PAPERS, INC.
INSTALLATION LOCATION	ASHDOWN, ARKANSAS
SOURCE CHARACTERISTICS	COAL (1% - 1.5% SULFUR)
SOURCE RATING	211,000 SCFM (TOTAL - 1 BOILER)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	105 MW (EQUIVALENT); DESIGN - 500,000 LB/HR STEAM (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	AIRPOL INDUSTRIES
CONTROL PROCESS	CAUSTIC SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	FEBRUARY, 1976
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90+% (600 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	98% - 99% (1.42 GR/SCF AT INLET)
WATER MAKE-UP	OPEN LOOP
SLUDGE OR BY-PRODUCT DISPOSAL	ALKALINE SULFITE/BISULFITE RECYCLED TO PULP PROCESS SO2 RECOVERED FROM SODIUM SULFITE/SULFATE LIQUOR AND RE-CYCLED TO PULPING PROCESS.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE NEKOOSA-EDWARDS PAPER PULP MILL IN ASHDOWN, ARKANSAS OPERATES A SINGLE 105 MW EQUIVALENT STEAM BOILER FIRED WITH COAL OR FUEL OIL. THE BOILER IS DESIGNED FOR 500,000 LB/HR STEAM AT 850 PSI. THE COAL HAS 1-1.5% SULFUR AND A HEATING VALUE OF 12,000 BTU/LB. IT IS BURNED AT A RATE OF 27 TONS/HR. THE BOILER IS OPERATED CONTINUOUSLY AT (24 HRS/DAY) 40% TO 60% LOAD.

TWO AIRPOL VARIABLE THROAT VENTURI SCRUBBERS ARE DESIGNED TO REMOVE BOTH SULFUR DIOXIDE AND PARTICULATE AT AN AVERAGE PRESSURE DROP OF 14-16 INCHES W.G. THE INTENT OF NEKOOSA-EDWARDS WAS TO MAKE, FROM THE SCRUBBER EFFLUENT, SALTCAKE WHICH WOULD BE USED AT THE MILL. EACH VENTURI IS FOLLOWED BY A CYCLONIC SEPARATOR. THE SEPARATORS ARE MILD STEEL WITH FLAKEGLASS LININGS. EACH SCRUBBER HANDLES HALF OF THE INCOMING FLUE GAS, THE TOTAL AMOUNT OF GAS BEING 325,000 ACFM AT 355 F. THE INLET SO2 CONCENTRATION IS TYPICALLY 600 PPM WITH A PARTICULATE LOADING OF 1.42 GAL/SCFM. SCRUBBING LIQUOR IS RECIRCULATED AT A RATE OF 2,000 GPM THROUGH PUMPS RATED AT 2,200 GPM.

THE TWO RECIRCULATION TANKS ARE MILD STEEL AND ARE LINED. THERE SIZE IS ESTIMATED TO BE 15 FEET HIGH X 10 FEET IN DIAMETER. BLOWDOWN FROM THE RECIRCULATION TANKS IS 300 GPM THROUGH PUMPS RATED AT 300 GPM. FROM THE RECIRCULATION TANKS, THE BLOWDOWN GOES TO AN ASH POND, THEN A STABILIZATION POND AND FINALLY THE RIVER. SCRUBBER UNDERFLOW CONSISTS OF FLYASH AND A SOLUTION OF NA2SO3/SO4.

NEKOOSA PAPERS, INC.; ASHDOWN, ARKANSAS (CONTINUED)

CAUSTIC IS USUALLY OBTAINED AS A WASTE STREAM AFTER THE PULP BLEACHING STAGE. IT IS USED AT A RATE OF 500-600 GPM, OR 12 LB/MIN OF SODIUM HYDROXIDE AND IS ADDED TO THE RECIRCULATION TANK. PURCHASED CAUSTIC IS OCCASIONALLY USED. IT IS USED AS A 50% SOLUTION, EXACTLY THE WAY IT IS PURCHASED. THE USAGE RATE IS 1 TO 4 GPM AND IT IS INJECTED ON THE SUCTION SIDE OF THE RECIRCULATION PUMP. THE PH OF THE ENTERING CAUSTIC IS 10.5 TO 11. THE PH IN THE RECIRCULATION TANK IS 5.5 TO 6.0. PH PROBES ARE LOCATED IN THE FIBERGLASS LINE BETWEEN THE SEPARATOR AND RECIRCULATION TANK.

GASES ARE EXHAUSTED THROUGH A FLAKEGLASS LINED STACK APPROXIMATELY 12 FEET IN DIAMETER AND 200+ FEET IN HEIGHT. THE OUTLET TEMPERATURE IS 125 F. THERE IS NO REHEAT.

THE PREDOMINANT DIFFICULTIES WITH THE FGD SYSTEM HAVE BEEN TWO-FOLD. FIRST, THE PLANT HAS BEEN UNABLE TO DEVELOP AN ADEQUATE PH CONTROL MECHANISM. THE PH CONTROL SYSTEM MONITORS THE AMOUNT OF CAUSTIC AGENT, I.E., SODIUM HYDROXIDE, WHICH GOES INTO THE RECYCLE TANK, KEEPING THE PH OF THE SCRUBBER SOLUTION AT A NONCORROSIVE LEVEL. THE PLANT HAS BEEN PLAGUED WITH PROBLEMS IN OPERATING THE PH CONTROL SYSTEM AND HAS SUFFERED A GREAT DEAL OF CORROSION. THE SECOND PROBLEM CONCERNS THE CHEMICAL REGENERATION PORTION OF THE SYSTEM. THE INTENT OF THE PLANT WAS TO SEPARATE THE FLY ASH FROM THE SCRUBBER LIQUID AND TAKE THE SCRUBBER LIQUID THROUGH A SERIES OF EVAPORATORS WHERE SODIUM SULFATE, I.E., SALTCAKE, WOULD BE GENERATED. THE PLANT HAS BEEN UNABLE TO OPERATE THE FLY ASH SEPARATION SYSTEM PROPERLY, AND THERE IS NOT ENOUGH EVAPORATION CAPACITY FOR THE PLANT TO PROCESS THE SCRUBBER EFFLUENT AT FULL OPERATIONAL CAPACITY.

IN SPITE OF THE OPERATIONAL PROBLEMS, THE SULFUR DIOXIDE AND PARTICULATE REMOVAL EFFICIENCIES OF THE FGD SYSTEM ARE 90 AND 99 PERCENT, RESPECTIVELY, ACCORDING TO THE PLANT ENGINEER. THE WASTE PRODUCT FROM THE SCRUBBER IS NOT RECYCLED, AT PRESENT, AND IS PUMPED TO THE WASTEWATER TREATMENT PLANT.

UPON STARTUP, PROBLEMS OCCURRED WITH THE PIPING AND VALVES WHICH WERE CONSTRUCTED OF CARBON STEEL. THE CARBON STEEL SYSTEM WAS REMOVED AND REPLACED WITH STAINLESS STEEL VALVES AND PIPING. SOME PIPING LEAKS OCCURRED AND WERE REWELDED. SOME CORROSION OF DUCT DAMPERS OCCURRED AND WERE RELIEVED BY ADJUSTING THE PH OF THE SCRUBBING LIQUOR.

REFER TO FIGURE 14-37 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1977   NO MAJOR PROBLEMS WERE REPORTED. CORROSION PROBLEMS STILL EXIST AND PH CONTROL IS STILL A PROBLEM. FLOW METERS ARE BEING INSTALLED TO MONITOR SCRUBBER WATER.

4TH QUARTER-1977   TWO IN LINE FLOW METERS WERE INSTALLED ON EACH SCRUBBER, ONE AT THE THROAT INLET OF THE VENTURI AND ONE AT THE THROAT. THE PLANT REPORTED THAT PH CONTROL WAS STILL A PROBLEM. SOME PROBLEMS WERE BEING ENCOUNTERED WITH THE PH PROBES DUE TO THE CONSTANT FLOW OF LARGE AMOUNTS OF SOLIDS, AND SOLIDS DEPOSITS ON THE PROBES.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

NEKOOSA PAPERS, INC.; ASHDOWN, ARKANSAS (CONTINUED)

2ND QUARTER-1978   NO MAJOR PROBLEMS OCCURRED DURING THE REPORT PERIOD. IN JUNE A PARTICULATE COMPLIANCE TEST WAS RUN. PARTICULATE EMISSIONS WERE 0.05 LB/MM BTU AGAINST THE 0.1 LB/MM BTU REGULATION. CAUSTIC SCRUBBING SOLUTION IS CYCLED TO THE SCRUBBER FROM THE PULP BLEACH PLANT AT 400 GPM. THE BOILER OPERATED 2155 HOURS AT 40% TO 60% CAPACITY. DURING THAT PERIOD THE SCRUBBER DEMONSTRATED 100% OPERABILITY.

3RD QUARTER-1978   DURING THIS REPORT PERIOD THE ONLY PROBLEM THAT WAS REPORTED WAS A RECYCLE PUMP FAILURE CAUSING ONE SCRUBBER TO BE DOWN FOR APPROXIMATELY 1.5 DAYS. HOWEVER, DUE TO THE PARALLEL ARRANGEMENT OF THE SCRUBBING TRAINS AND LOW OPERATING LEVEL OF THE BOILER (40 - 60%), THE TOTAL FLUE GAS FLOW WAS ROUTED THROUGH THE REMAINING SCRUBBER TRAIN. THE BOILER WAS REPORTED TO OPERATE 24 HOURS PER DAY DURING THIS PERIOD.

4TH QUARTER-1978   DUE TO THE PARALLEL ARRANGEMENT OF THE SCRUBBER MODULES AND LOW BOILER LOADS, SCRUBBER-RELATED BOILER DOWNTIME IS RARE. THE ENTIRE VOLUME OF FLUE GAS CAN BE ROUTED TO ONE OF THE SCRUBBERS WHEN THE OTHER NEEDS MAINTENANCE WORK. HOWEVER, THE PLANT IS CURRENTLY UNDERGOING EXPANSION WHICH WILL REQUIRE BOILER LOADS OF 80% TO 90%. THIS WILL MEAN THAT THE ENTIRE VOLUME OF GAS WILL NOT BE ABLE TO BE ROUTED THROUGH ONE MODULE AND PLANT PERSONNEL REPORT THAT THEY EXPECT MORE BOILER DOWNTIME DUE TO FGD PROBLEMS OR AT LEAST REDUCED OPERATING LOADS.

DURING THIS QUARTER, THE LINING OF ONE OF THE SEPARATORS WAS PATCHED. THE LINING HAD BEEN CHIPPING OFF CAUSING THE MILD STEEL SHELL TO CORRODE. CORROSION LEAKS IN THE SEPARATOR WERE ALSO REPAIRED. THE BOILER WAS NOT SHUT DOWN. PLANS HAVE BEEN MADE TO RELINE THE SEPARATORS WITH AN AS YET UNDETERMINED LINING MATERIAL IN THE SPRING.

PURCHASED CAUSTIC ($700-$800/DAY) WAS USED 3 TO 4 WEEKS THIS QUARTER SINCE THE PUMP THAT DELIVERS THE ON-SITE CAUSTIC FROM THE PULP BLEACHING OPERATION BROKE DOWN DUE TO A MECHANICAL FAILURE. NO SCRUBBER DOWNTIME RESULTED.

PH PROBES ARE CLEANED TWICE WEEKLY. AN AVAILABILITY OF 100% WAS DEMONSTRATED BY THE FGD SYSTEM.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	NORTHERN OHIO SUGAR COMPANY
INSTALLATION LOCATION	FREEMONT, OHIO
SOURCE CHARACTERISTICS	COAL (1% SULFUR)
SOURCE RATING	40,000 SCFM (TOTAL - 2 BOILERS) 140,000 LB/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
CONTROL SYSTEM VENDOR	GREAT WESTERN SUGAR
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	OCTOBER, 1975
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO CITY SEWER
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE FGD SYSTEM CURRENTLY OPERATING AT THE FREEMONT, OHIO PLANT OF GREAT WESTERN SUGAR HAS BEEN DESIGNED FOR BOTH SO2 AND PARTICULATE CONTROL. THE SYSTEM CONSISTS OF A VARIABLE THROAT VENTURI SCRUBBER WITH A SINGLE PASS, THREE STAGE CHEVRON DEMISTER.

A BLEED-OFF STREAM OF SCRUBBER EFFLUENT IS CONTINUOUSLY DISCHARGED TO A HOLDING POND FOR TREATMENT.

REFER TO FIGURE 14-26 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	RICKENBACKER AIR FORCE BASE
INSTALLATION LOCATION	COLUMBUS, OHIO
SOURCE CHARACTERISTICS	COAL (3.6% SULFUR)
SOURCE RATING	55,000 SCFM (TOTAL - 7 BOILERS) 277,000 LB/HR STEAM
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	7
SOURCE CAPACITY	27 MW (EQUIVALENT); TOTAL - 7 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	RESEARCH-COTTRELL/BAHCO
CONTROL PROCESS	LIMESTONE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	MARCH, 1976
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90%+ (DESIGN) ACTUAL REMOVAL IS NOW LOWER DUE TO EASING OF REGULATIONS.
PARTICULATE REMOVAL EFFICIENCY	98%
WATER MAKE-UP	OPEN LOOP - 2.5 GPM/MW (MAX)
SLUDGE OR BY-PRODUCT DISPOSAL	NON-FIXATED SLURRY TO LINED POND UNSTABILIZED CASO3/SO4 SLUDGE TO LINED POND
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

ON MARCH 11, 1976 THE FIRST U.S. INSTALLATION OF THE SWEDISH BAHCO SULFUR DIOXIDE REMOVAL SYSTEM WAS PLACED IN SERVICE AT RICKENBACKER AIR FORCE BASE IN COLUMBUS, OHIO. THE SYSTEM, MANUFACTURED BY A.B. BAHCO VENTILATION OF ENKOPING, SWEDEN, DISTRIBUTED EXCLUSIVELY IN THE UNITED STATES BY RESEARCH/COTTRELL, WAS ORIGINALLY INSTALLED AT RICKENBACKER TO HANDLE THE FLUE GAS FROM SEVEN 31 MM BTU/HR STOKER-TYPE COAL FIRED BOILERS INSTALLED BETWEEN 1954 AND 1956. IN JUNE 1977, A NEW 60 MM BTU/HR BOILER CAME INTO SERVICE. THIS UNIT REPLACED 2 OF THE OLDER BOILERS, AND A THIRD WAS PLACED ON STAND-BY. THE BOILERS ALL FIRE A HIGH SULFUR (3.6%) COAL.

THE RICKENBACKER EMISSION CONTROL SYSTEM CONSISTS ESSENTIALLY OF A MECHANICAL COLLECTOR, 2-STAGE BACHO SCRUBBER TOWER, LIMESTONE STORAGE AND HANDLING SYSTEM, CLARIFIER, BOOSTER FAN AND ASSOCIATED DUCT-WORK, PUMPS, CONTROLS, AND A SLUDGE DISPOSAL POND.

SOLID PARTICULATE AND SULFUR DIOXIDE-LADEN FLUE GAS TAKEN FROM EACH OF THE EXISTING SIX STACKS IS FED THROUGH A COMMON HEADER AND INTO A MECHANICAL COLLECTOR WHERE PRIMARY PARTICULATE REMOVAL TAKES PLACE. THE MECHANICAL COLLECTOR HAS A DESIGN REMOVAL EFFICIENCY OF 70 PERCENT AND WAS INSTALLED PRIMARILY TO REDUCE FAN WEAR. THE PARTIALLY CLEANED GAS THEN FLOWS INTO THE BACHO

RICKENBACKER AIR FORCE BASE: COLUMBUS, OHIO (CONTINUED)

TOWER WHERE ADDITIONAL PARTICULATE AND PRIMARY SULFUR DIOXIDE REMOVAL TAKES PLACE.

THE BACHO SCRUBBING VESSEL IS A VERTICAL TOWER CONSISTING OF TWO SCRUBBING STAGES. GAS FLOWS THROUGH THE TOWER WHERE IT IS CONTACTED WITH A LIMESTONE SLURRY. AFTER PASSING THROUGH THE FIRST SCRUBBING STAGE, ENTRAINED MOISTURE IS REMOVED BY A CYCLONIC TYPE MIST ELIMINATOR. THE GAS THEN PASSES THROUGH A SECOND SCRUBBING STAGE AND A SECOND CYCLONIC MIST ELIMINATOR. THE CLEANED GAS IS DISCHARGED TO THE ATMOSPHERE THROUGH A STUB STACK ATOP THE ABSORBER TOWER.

FINE MESH LIMESTONE IS EMPLOYED AS THE REAGENT IN THE SCRUBBING SYSTEM. THE SCRUBBING SLURRY IS PUMPED TO THE ABSORBER WHERE IT IS CONTACTED WITH THE FLUE GAS IN A COUNTERCURRENT FASHION.

THE SPENT SCRUBBING SOLUTION IS DISCHARGED TO THE THICKENER WHERE THE WASTE SOLIDS SETTLE OUT. THICKENER OVERFLOW IS RETURNED TO THE MIX/HOLD TANK. THICKENER UNDERFLOW IS DISCHARGED TO A 5-ACRE HYPALON-LINED DISPOSAL POND. THIS POND IS LOCATED APPROXIMATELY 400 FEET FROM THE ABSORBER TOWER. CLEAR WATER FROM THE POND IS RETURNED TO THE PROCESS AS MAKE-UP WATER IN THE SLURRY TANK.

REFER TO FIGURE 14-39 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

MAR. 76 THROUGH OCT. 76 THE INITIAL OPERATION PROCEEDED IN AN OPEN-WATER-LOOP MODE BECAUSE THE THICKENER WAS NOT YET COMPLETELY INSTALLED. SULFUR DIOXIDE INLET CONCENTRATIONS WERE IN THE 1800 TO 2000 PPM RANGE. HIGH OXYGEN CONCENTRATIONS ALSO EXISTED IN THE FLUE GAS BECAUSE THESE OLDER, INEFFICIENT BOILERS OPERATE AT 150 TO 160 PERCENT EXCESS AIR RATES. SULFER DIOXIDE REMOVAL EFFICIENCY WAS IN THE LOW 90 PERCENT PLUS RANGE. EARLY PROBLEMS WERE PRIMARILY OF A MECHANICAL NATURE USUALLY ASSOCIATED WITH START-UP. THE MAJOR START-UP PROBLEMS WERE AS FOLLOWS:

UP PROBLEMS WERE AS FOLLOWS:

1. ELECTRICAL CIRCUITS AND SYSTEM CONTROL PANEL.
2. PUMP MALFUNCTION-SPARE PARTS SHIPMENT DELAY.
3. SEDIMENTATION BUILDUP IN THE SCRUBBER VESSEL (THIS WAS DUE PRIMARILY TO OPERATION AT HIGHER THAN DESIGN SOLIDS CONCENTRATION IN THE SCRUBBING SOLUTION BECAUSE THE THICKENER WAS NOT YET IN SERVICE PLUS GRIT GETTING THROUGH THE LIME SLAKER GRIT REMOVAL STEP).
4. FAMILIARIZATION OF THE OPERATING STAFF WITH THE MECHANICS OF THE PROCESS.
5. I.D. BOOSTER FAN PROBLEMS. ADDITIONAL BRACING, AND EPOXY GROUTING WAS REQUIRED TO STOP THE ELEVATED FAN CONCRETE SUPPORT FROM VIBRATING WHILE THE FAN WAS OPERATING.

NOV. 76 THROUGH JUN. 77 DOWNTIME WAS LESS THAN 5%. OPERATING PROBLEMS WERE MECHANICAL- AND CONTROL- RATHER THAN PROCESS-RELATED. FAN-RELATED PROBLEMS ACCOUNTED FOR OVER 75% OF THE ACTUAL DOWN-TIME. THIS RESULTED FROM EXCESSIVE FAN VIBRATIONS CAUSED BY BEARING, SUPPORT, AND INSTRUMENTATION DIFFICULTIES. IN APRIL 1977, THE FAN WHEEL DEVELOPED A CRACK IN THE RIM ATTRIBUTED TO FATIGUE FROM RESONANT VIBRATION. THE FAN WAS SENT BACK TO THE MANUFACTURER, AMERICAN STANDARD, WHO

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

RICKENBACKER AIR FORCE BASE: COLUMBUS, OHIO (CONTINUED)

MADE THE REQUIRED MODIFICATIONS. THE ORIGINAL FAN WAS RADIAL BLADE WITH RIMS, AND A MAJOR MODIFICATION WAS CHOPPING THE RIMS OFF, THEREBY REDUCING THE DIAMETER. THE FAN WAS RETURNED IN EARLY MAY AND THE VIBRATION PROBLEM WAS SOLVED. OTHER OPERATIONS WERE RELATIVELY PROBLEM-FREE. THERE WERE NO CORROSION, EROSION, SCALING, OR PLUGGING PROBLEMS. THE SYSTEM BEGAN RUNNING ON LIMESTONE IN APRIL, AS PART OF THE EPA TEST PROGRAM. LIMESTONE PERFORMED WELL, YIELDING ADEQUATE REMOVAL.
ON JUNE 3RD, THE STEAM PLANT WAS SHUTDOWN FOR THE TIE-IN OF THE NEW NO. 8 BOILER. TIE IN WAS COMPLETED IN JUNE.

AUG. 77   THE ARMS BROKE OFF IN THE 25-FOOT DIAMETER THICKENER TANK, CAUSING A 30 DAY DOWNTIME.
SEP. 77   A MAKE-UP WATER BOOSTER PUMP HAD TO BE REPLACED.
OCT. 77   THE MOTOR DRIVE ON THE SLAKER BELT HAD TO BE REPAIRED. ALTHOUGH THE SLAKER IS NO LONGER USED WITH THE LIMESTONE REAGENT, THE BELT IS USED TO CONVEY THE LIMESTONE TO THE DISSOLVING TANK.

1ST QUARTER-1978   IT WAS DISCOVERED THAT WITH A STOICHIOMETRIC RATIO OF 0.75 THE REQUIRED DEGREE OF SO2 REMOVAL CAN BE ACHIEVED. THE CURRENT REGULATION LIMITS EMISSIONS TO 2.2 LBS/MM BTU HEAT INPUT. DURING THE JANUARY BLIZZARD, SOME FREEZE-UP PROBLEMS WERE ENCOUNTERED.
DURING JANUARY THE BOILERS OPERATED 744 HOURS AND THE FGD SYSTEM OPERATED 596 HOURS YIELDING OPERABILITY AND AVAILABILITY INDEX VALUES OF 80%. ALL DOWNTIME WAS ATTRIBUTABLE TO FREEZE-UPS DURING BLIZZARD CONDITIONS. DURING FEBRUARY, THE BOILERS OPERATED 672 HOURS AND THE CONTROL SYSTEM OPERATED 168 HOURS. HOWEVER THE FGD SYSTEM WAS AVAILABLE 551 HOURS. THEREFORE THE OPERABILITY INDEX WAS 25% WHILE THE AVAILABILITY WAS 82%. THE ABSORBER LINES WERE THAWED OUT FEBRUARY 6, BUT DURING FEBRUARY, THE GOVERNOR OF OHIO TEMPORARILY SHELVED POLLUTION CONTROL REGULATIONS. THEREFORE THE FGD SYSTEM WAS NOT OPERATED ALTHOUGH IT WAS AVAILABLE FOR OPERATION. THE SYSTEM WAS SHUTDOWN ON FEBRUARY 13 AND DID NOT OPERATE DURING MARCH.

2ND QUARTER-1978   SYSTEM WAS RESTARTED APRIL 10 AND WAS REPORTED TO HAVE RUN WITH A 100% OPERABILITY INDEX VALUE FOR THE REMAINING PERIOD. PLANT REPORTED THAT ALL PREVIOUS PROBLEMS HAVE BEEN CORRECTED. DURING THE LAST PORTION OF THE 2ND QUARTER THE BOILER LOAD DROPPED TO ITS SUMMER LEVEL, ABOUT 30 MM BTU/HR, AS OPPOSED TO THE MAXIMUM COLD SEASON LOAD OF 150 MM BTU/HR.

3RD QUARTER-1978   THE SYSTEM OPERATED WITH AN AVAILABILITY INDEX OF OVER 99.5% FOR THE PERIOD. THE SCRUBBER WAS CLEANED AND INSPECTED DURING A 5-DAY BOILER MAINTENANCE OUTAGE AND FOUND TO BE RELATIVELY FREE OF CORROSION AND SCALING. THE SYSTEM WAS OBTAINING ABOUT 75% SO2 REMOVAL, WHICH WAS SUFFICIENT TO MEET THE REGULATION. WHILE THE BOILER IS OPERATING AT ITS REDUCED SUMMER LOAD, FRESH MAKE-UP AIR IS BEING MIXED WITH THE FLUE GAS ENTERING THE F.D. FAN TO MAINTAIN FULL GAS PRESSURE AND VELOCITY THROUGH THE ABSORBER.

RICKENBACKER AIR FORCE BASE: COLUMBUS, OHIO (CONTINUED)

4TH QUARTER-1978 THE FGD SYSTEM EXPERIENCED 36 HOURS OF DOWNTIME DURING THE PERIOD FOR AN OVERALL AVAILABILITY INDEX OF 98.4%. MOST OF THE DOWNTIME WAS CAUSED BY A BROKEN WELD ON THE FAN HOUSING. THE NUCLEAR DENSITY CONTROL VALVE ON THE CLARIFIER UNDERFLOW DEVELOPED PROBLEMS AND WAS REPAIRED BY THE MANUFACTURER. THE SCRUBBER OPERATOR REPORTED THAT SHUTDOWN/STARTUP IS A SMOOTH PROCEDURE. A CLEANOUT/MAINTENANCE SHUTDOWN IS TENTATIVELY SCHEDULED FOR LATE WINTER.

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	ST. REGIS PAPER CO.
INSTALLATION LOCATION	CANTONMENT, FLORIDA
SOURCE CHARACTERISTICS	BARK,OIL/GAS (< 1.0% SULFUR)
SOURCE RATING	115,000 SCFM (1 BOILER)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	57 MW (EQUIVALENT); DESIGN - 300,000 LB/HR STEAM (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	AIRPOL INDUSTRIES
CONTROL PROCESS	CAUSTIC SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	1973
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	80% - 90%
PARTICULATE REMOVAL EFFICIENCY	94.5% (400 LB/HR AT INLET)
WATER MAKE-UP	OPEN LOOP; 200 GPM-250 GPM SCRUBBING LIQUOR FEED
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT EFFLUENT IS TREATED IN AN ON-SITE SEWAGE TREATMENT PLANT
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE BOILER AT ST. REGIS PAPER LOCATED IN CANTONMENT, FLORIDA IS RATED AT 57 MW EQUIVALENT AND PRODUCES 300,000 LBS/HR STEAM. THE TYPICAL SULFUR CONTENT OF THE FUEL (OIL OR BARK, NATURAL GAS) IS LESS THAN 1%. THE HEATING VALUES OF THE FUELS ARE AS FOLLOWS: BARK @ 50% MOISTURE IS 4030 BTU/LB, THE OIL IS 6,000,000 BTU/BARREL AND THE GAS IS 1400 BTU PER CUBIC FOOT.

THE SCRUBBER SYSTEM WAS RETROFITTED BY AIRPOL IN 1973. THE UNIT IS CONSTRUCTED OF 316L STAINLESS STEEL AND HANDLES A TOTAL FLUE GAS VOLUME OF 175,000 ACFM. PARTICULATES ARE CONTROLLED BY CYCLONES PRECEDING THE SCRUBBER. SCRUBBER PRESSURE DROP IS APPROXIMATELY 10 IN. W.G. WITH 80-90% SULFUR DIOXIDE REMOVAL EFFICIENCY. THE SCRUBBER IS FOLLOWED BY A CHEVRON-TYPE MIST ELIMINATOR.

SCRUBBER UNDERFLOW CONSISTS OF ASH AND A SODIUM SULFITE/SULFATE SOLUTION. BLOWDOWN FROM THE SCRUBBER OCCURS EVERY FEW MINUTES. TO MAINTAIN THE RECIRCULATION TANK AT A CONSTANT VOLUME, A SOLENOID IS USED WHICH AUTOMATICALLY OPENS A VALVE AND INTRODUCES MAKE-UP WATER WHEN THE LEVEL OF THE LIQUOR DROPS TO A CERTAIN POINT. THE TANK HAS A CAPACITY OF 4000-5000 GALLONS AND IS MADE OF 304 STAINLESS STEEL. A BLEED-OFF STREAM FROM THE RECIRCULATION TANK IS SENT TO AN ON-SITE SEWAGE TREATMENT PLANT WHERE IT RECEIVES PRIMARY CLARIFICATION AND AERATION/STABILIZATION STABILIZATION FOR REDUCTION OF BIOLOGICAL OXYGEN DEMAND (BOD).

REFER TO FIGURE 14-42 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

ST. REGIS PAPER CO.: CANTONMENT, FLORIDA (CONTINUED)

OPERATING HISTORY

3RD QUARTER-1977 WOOD FIBERS FROM BARK WERE CLOGGING SEPARATORS AND CONTROL VALVES. INSPECTION WAS MADE AND SOLUTION TO PROBLEM WAS BEING INVESTIGATED.

4TH QUARTER-1977 AFTER INVESTIGATION OF THE CLOGGING PROBLEM IT WAS DECIDED TO CHANGE THE MAKE-UP WATER SOURCE. WATER IS NOW OBTAINED FROM A CLEANER PORTION OF THE PROCESS LOOP. PLANT REPORTS SATISFACTORY OPERATIONS WITH NO OTHER MAJOR PROBLEMS.

2ND QUARTER-1978 PLUGGING DUE TO FIBERS IN THE SCRUBBER FEEDWATER REMAINED TO BE AN UNSOLVED PROBLEM DURING THE REPORT PERIOD. PLANT HAD NOT YET CHANGED THE SCRUBBER LIQUOR FEED SOURCE. IN THE JANUARY THROUGH MAY PERIOD, THE BOILER OPERATED 3473 HOURS. SCRUBBER RELIABILITY INDEX WAS NEAR 100%. THE PLANT INDICATED THAT THIS REPORT HAD BEEN REPORTING TOO HIGH A SULFUR CONTENT IN THE FUEL (2-3 %), AS COMPARED TO THE CORRECT VALUE OF LESS THAN 1%.

3RD QUARTER-1978 THE SCRUBBER LIQUOR FEED SOURCE HAS NOT BEEN CHANGED, HENCE, PLUGGING STILL REMAINS AN UNSOLVED PROBLEM. HOWEVER, THE PLANT REPORTED GOOD OPERATION FOR THIS QUARTER. FROM JANUARY THROUGH JULY, THE BOILER BURNED BARK FOR 4223 HOURS AND GAS AND OIL FOR 665 HOURS. THE TOTAL TIME THE BOILER WAS IN OPERATION WAS 4888 HOURS. THE SCRUBBER EXHIBITED 100% AVAILABILITY.

4TH QUARTER-1978 THE FGD SYSTEM OPERATED PROBLEM FREE FOR THIS QUARTER. THE SCRUBBER FEEDWATER SOURCE HAS BEEN CHANGED FROM THE SCREEN ROOM BLACKWATER TO EVAPORATOR CONDENSATE WATER. PLANT PERSONNEL FEEL THIS SHOULD ALLEVIATE THE PLUGGING PROBLEMS. RELIABILITY AND OPERABILITY INDICES WERE 100%.

DURING THE MONTH OF AUGUST, THE BOILER BURNED BARK FOR 564 HOURS; OIL WAS BURNED 88 HOURS YIELDING A TOTAL TIME OF OPERATION OF 652 HOURS FOR THE BOILER. IN SEPTEMBER, BARK WAS BURNED 715 HOURS, OIL, 5 HOURS. IN OCTOBER, BARK WAS BURNED 627 HOURS, OIL, 45 HOURS. GAS WAS AVAILABLE AS BACK-UP.

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	TEXACO INCORPORATED
INSTALLATION LOCATION	SAN ARDO, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.7% SULFUR)
SOURCE RATING	380,000 SCFM (TOTAL - 32 BOILERS) 24,000 ACFM @ 600 F, FOR EACH OF 25 FGD SYSTEMS 70,000 ACFM @ 600 F, FOR EACH OF 2 FGD SYSTEMS 10,000 ACFM @ 600 F, FOR EACH OF 5 SYSTEMS
NUMBER OF SEPARATE FGD UNITS	32
NUMBER OF BOILERS BEING CONTROLLED	32
SOURCE CAPACITY	190 MW (EQUIVALENT); 710 MM BTU/HR: TOTAL- 32 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	CEILCOTE
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	NOVEMBER, 1973
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	73% (1000 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT HALF OF THE SCRUBBER UNDERFLOW IS TREATED AND RECYCLED AS BOILER FEEDWATER; THE OTHER HALF GOES TO WASTEWATER DISPOSAL WELLS.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

TEXACO USES SEVERAL OIL-FIRED BOILERS AT THE SAN ARDO, CALIFORNIA SITE. THE STEAM IS INJECTED INTO OIL WELLS TO FACILITATE OIL FLOW. THERE ARE THREE DIFFERENT SIZES OF THE BOILERS: 2 @ 180 MM BTU/HR, AND 25 @ 50 MM BTU/HR, AND 5 @ 20 MM BTU/HR. THE FUEL OIL HAS A TYPICAL SULFER CONTENT OF 1.7%.

THE FLUE GASES (70,000 ACFM FROM THE LARGE, 24,000 ACFM FROM THE INTERMEDIATE, AND 10,000 ACFM FROM THE SMALL GENERATORS @ 600 F) ARE SCRUBBED BY FGD SYSTEMS SUPPLIED BY CEILCOTE COMPANY IN NOVEMBER 1973. EACH BOILER IS FOLLOWED BY A QUENCHING CHAMBER AND A SCRUBBER. THE SCRUBBERS, WHICH ARE HORIZONTAL TOWERS PACKED WITH 2 IN. TELLERITE PACKINGS, ARE OF SIZES: 15 FT X 20 FT (2 UNITS), 7 FT X 8 FT X 12 FT (25 UNITS), AND THE GAS FLOWS ACROSS THE HORIZONTAL SCRUBBER WHEREAS THE LIQUID IS SPRAYED PRIMARILY IN A CROSS-CURRENT MODE. THE ABSORBER SECTION IS FOLLOWED BY A SHORTER PACKED DEPTH WHICH SERVES AS A MIST ELIMINATOR (M-E). THE SCRUBBING LIQUOR IS A MIXTURE OF NATURAL WATER AND 50% NAOH SOLUTION. THE TYPICAL LIQUID MASS FLUX VALUES ARE 2000 - 3000 LBS/HR FT2. A L/G RATIO OF 14 GAL/1000 SCF IS USED AND PH AT THE INLET IS 8.0. THE FLUE GASES

TEXACO INCORPORATED; SAN ARDO, CALIFORNIA (CONTINUED)

ENTER THE QUENCHERS AT 600 F WITH 1000 PPM SO2 AND LEAVE THE M-E'S AT 160 F WITH 270 PPM SO2. THE SPENT LIQUOR IS SPLIT INTO TWO STREAMS, ONE RECYCLED AS BOILER FEED WATER AFTER REMOVING FLYASH AND SOFTENING, THE OTHER IS DISPOSED OF IN WASTE-WATER DISPOSAL WELLS.

THE ABSORBER MODULES, DOWNSTREAM DUCTWORK, STACK AND THE I.D. FAN ARE MADE OF FRP, WHEREAS THE PACKING IS POLYPROPYLENE. THE QUENCHER SECTION IS 316 SS, WHEREAS THE SPENT LIQUOR PIPING, CAUSTIC TANKS, AND THE CAUSTIC FEED LINES ARE MILD STEEL.

REFER TO FIGURE 14-44 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

THE MAJOR OPERATIONAL PROBLEM AREAS ARE:

1. THE QUENCHER SECTION HAS SUFFERED SEVERE CORROSION DUE TO ACID ATTACK.
2. FRP LINER DETERIORATES DUE TO MECHANICAL ABRASION DURING CLEANING OPERATIONS. IT NEEDS OCCASIONAL RESURFACING.
3. THE PACKED BEDS ARE FREQUENTLY PLUGGED BY FLYASH. THE OIL IN THE NATURAL LIQUOR HAS CAUSED FOULING OF THE PACKED BEDS.
4. OCCASIONAL OVERINJECTION OF CAUSTIC HAS RESULTED IN PLUGGING OF SPRAY NOZZLES BY SCALE.

1ST QUARTER-1978 DUE TO THE LOW SO2 REMOVAL AND HIGH MAINTENANCE COST OF THE ABOVE DESIGN, TEXACO HAS UNDERTAKEN A TEST PROGRAM WHICH, IF SUCCESFUL, WILL PHASE OUT THE PRESENT SCRUBBERS BY THE END OF 1979. FOR MORE INFORMATION ON THE PROGRAM SEE THE OTHER TEXACO, SAN ARDO BACKGROUND INFORMATION ENTRY IN SECTION 10 OF THIS REPORT.

2ND QUARTER-1978 THE AVAILABILITY OF EACH FGD SYSTEM WAS APPROXIMATELY 94%. ON AN AVERAGE, ONE SYSTEM WAS SHUTDOWN TWO DAYS A MONTH FOR MAINTENANCE.

3RD QUARTER-1978 THERE WAS NO MAJOR DOWNTIME DUE TO EQUIPMENT OR PROCESS FAILURE. THE SCRUBBERS WERE DOWN FOR SCHEDULED MAINTENANCE FOR ABOUT 8 HOURS PER MONTH REQUIRING ABOUT 24-MAN-HOURS PER UNIT. GENERALLY DURING THIS REGULAR MAINTENANCE PERIOD THE PACKING IS REPLACED AND THE INTERNALS INSPECTED AND CLEANED. TEXACO IS CONSIDERING CONVERTING FROM NAOH TO NA2CO3 AS THE REAGENT. NO TIMETABLE HAS BEEN ESTABLISHED FOR SUCH A TRANSITION.

4TH QUARTER-1978 OPERATIONAL PROBLEMS OF CORROSION IN THE QUENCHER, AND ABRASION AND PLUGGING IN ABSORBER CONTINUED. THE ABSORBERS ARE MOUNTED ATOP THE GENERATORS WITH ONLY 1 OR 2 FT CLEARANCE. HENCE, THE HEAT LOSSES FROM THE RADIATION SECTION WEAKEN THE FRP SHELL OF THE ABSORBERS. IN THIS QUARTER, EACH SCRUBBER WAS SHUT DOWN FOR MAINTENANCE FOR AN AVERAGE TIME OF 100 HOURS.

SECTION 9 (CONTINUED)

PERFORMANCE DESCRIPTION FOR OPERATIONAL FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	TEXASGULF
INSTALLATION LOCATION	GRANGER, WYOMING
SOURCE CHARACTERISTICS	COAL (0.75% SULFUR)
SOURCE RATING	140,000 SCFM (TOTAL - 2 BOILERS) 600,000 LB/HR STEAM (TOTAL)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	70 MW (EQUIVALENT); TOTAL - 2 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	SWEMCO INC.
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	SEPTEMBER, 1976
CONTROL SYSTEM STATUS	OPERATIONAL
SO2 REMOVAL EFFICIENCY	90% (860 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	99.3% (HOT-SIDE ESP W/PRECEDING MECHANICAL COLLECTOR)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

TEXASGULF INC. HAS BEEN OPERATING A NEW SODA ASH PLANT (1 MM TONS/YR) AT GRANGER, WYOMING, SINCE SEPTEMBER 1976. TWO BOILERS GENERATE A TOTAL OF 600,000 LBS/HR SATURATED STEAM @ 300 PSIG. UNIT EFFICIENCY IS 85% WHEN BURNING WYOMING SUB-BITUMINOUS COAL, WHICH HAS 13.97% MOISTURE, 6.43% ASH, 0.75% SULFUR, AND A HEATING VALUE OF IS 10,424 BTU/LB ON AN AS-RECEIVED BASIS. EACH BOILER BURNS APPROXIMATELY 25,000 LB/HR OF THE COAL.

AFTER FLUE GASES LEAVE EACH BOILER, (156,150 ACFM @ 350 F) THEY PASS THROUGH A MECHANICAL COLLECTOR, ESP, ECONOMIZER, AND WET SCRUBBER. (THE ECONOMIZER IS LOCATED AFTER THE PRECIPITATER BECAUSE THE ASH FROM WESTERN COAL IS COLLECTED MORE EFFICIENTLY WHEN THE GAS IS HOT). THE CYCLONE AND ESP TOGETHER HAVE A PARTICULATE REMOVAL EFFICIENCY OF 99.3%. THE SCRUBBING UNITS, INSTALLED AT DOWNSTREAM OF THE ECONOMIZER, WERE SUPPLIED BY SWEMCO IN SEPTEMBER 1976. THE SYSTEM CONSISTS OF A QUENCHER, A SIEVE TRAY ABSORBER (15 FT DIA X 20.5 FT HIGH) AND A BYPASS. THE ENGINEERING WORK WAS DONE BY A.G. MCKEE & CO. FLUE GAS IS SPRAY-COOLED FROM 350 F TO 125 F AS IT ENTERS THE QUENCHER WITH 19 PVC NOZZLES ON FIBERGLASS HEADERS AND IS DIRECTED INTO THE CIRCULATING LIQUOR IN THE RESERVOIR. THE GAS BUBBLES UP THROUGH THE LIQUOR, ENTERS THE ADJACENT ABSORBER, TRAVELS UP THROUGH TWO SIEVE TRAYS, AND A MESH TYPE MIST ELIMINATOR OF TEFLON AT THE TOP. SCRUBBING LIQUOR (700 GPM TO THE ABSORBER, 300 GPM TO THE QUENCHER) IS RECIRCULATED FROM THE SCRUBBER PUMP TANK WHICH RECEIVES THE SCRUBBER EFFLUENT (1023 GPM). PH VALUE IS MAINTAINED AT 6.3. A CONSTANT

TEXASGULF: GRANGER, WYOMING (CONTINUED)

BLEED-OFF (250 TO 487 LB/MIN) CONTAINING 8% OF SODIUM SALTS IS PURGED TO A HOLDING POND FOR EVAPORATION. THE CLARIFIED MAKEUP WATER (60 TO 93 GPM) IS USED FOR M-E WASHING (15 GPM) AND QUENCHER SPRAY (45 TO 66 GPM). MAKEUP SODA ASH 30% BY WEIGHT, ISFED FROM A LIQUOR HEAD TANK TO THE SCRUBBER PUMP TANK AT A MINIMUM RATE OF 56 LB/MIN AND MAX. RATE OF 119 LB/MIN.

EACH ABSORBER IS DIVIDED VERTICALLY INTO TWO SECTIONS, ONE OF WHICH HAS A DAMPER AT THE TOP. THIS PERMITS CURTAILMENT OF GAS FLOW THROUGH HALF OF THE UNITS AT LOW LOADS. THE ABSORBER, THEREFORE, CAN OPERATE AT THE DESIGN EFFICIENCY WHEN THE BOILER PRODUCES FROM 25% TO 100% OF ITS RATED OUTPUT. THE ABSORBER BYPASS ALLOWS UP TO 25% OF THE INCOMING HOT FLUE GAS TO BE DIVERTED. TYPICALLY, TEXASGULF USES THE BYPASS TO KEEP THE FLUE GAS IN THE STACK 10 F WARMER THAN THAT AT THE SCRUBBER OUTLET. THE ABSORBERS ARE MADE OF CARBON STEEL WITH FLAKED GLASS LINING AND THE TRAYS ARE OF INCONEL 625. THE RECIRCULATION TANKS ARE MADE OF FRP AND THE STACK (7.5 FT ID X 150 FT HEIGHT) IS DOUBLEWALLED, INSULATED STEEL TYPE WITH FLAKED GLASS COATING BY CEILCOTE COMPANY.

REFER TO FIGURE 14-45 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

THE THROAT IN ONE OF THE QUENCHERS WAS REPLACED BY THAT OF INCONEL 625 BECAUSE OF CORROSION PROBLEMS.

1ST QUARTER-1978 THE OUTLET DUCTWORK, WHICH WAS CORRODED DUE TO THE ACID CONDENSATE, WAS TO BE REPLACED. THE SYSTEM OPERATED WITHOUT ANY MAJOR PROBLEMS.

2ND QUARTER-1978 DURING A MAJOR ELECTRICAL TURNAROUND, THE SCRUBBER MODULES WERE CLEANED AND REPAIRED, SLUDGE FROM THE TRAYS WAS REMOVED AND THE OUTLET DUCTWORK WAS REPLACED BY 304 SS. THE SO2 MEASURING INSTRUMENTS WERE BEING UPGRADED BY LEAN STEGLER, THE SUPPLIER.

3RD QUARTER-1978 DURING THE REPORT PERIOD, THE BOILER AND FGD SYSTEM WERE DOWN TWICE FOR SCHEDULED INSPECTION OUTAGES. DOWNTIME WAS 4 DAYS FOR ONE MODULE AND 2 DAYS FOR THE OTHER. SOME MINOR PLUGGING WAS OBSERVED DURING THE INSPECTION PERIODS.

4TH QUARTER-1978 DURING THIS PERIOD, OUTAGE OCCURRED ON NO. 2 BOILER FOR A DAY IN OCTOBER. IN NOVEMBER, THE NO. 2 BOILER WAS DOWN FOR SCHEDULED INSPECTION FOR 2.5 DAYS. DURING THIS TIME, THE TRAYS AND INTERIOR OF THE SCRUBBER WERE CLEANED. SOME OF THE PIPING LEADING TO TRAYS WAS REPLACED. SOME OF THE PLUGGED NOZZLES IN THE QUENCHER WERE EITHER CLEANED OR REPLACED. THE RELIABILITY INDEX VALUE FOR BOTH SCRUBBERS WAS ABOUT 100%.

SECTION 10

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	ARCO/POLYMERS, INC.
INSTALLATION LOCATION	MONACA, PENNSYLVANIA
SOURCE CHARACTERISTICS	COAL (3.0% SULFUR)
SOURCE RATING	236,000 SCFM (TOTAL - 3 BOILERS) 900,000 LB/HR STEAM @ 700 PSIG AND 700 F.
NUMBER OF SEPARATE FGD UNITS	3
NUMBER OF BOILERS BEING CONTROLLED	3
SOURCE CAPACITY	118 MW (EQUIVALENT); TOTAL - 3 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	DOUBLE ALKALI (CONCENTRATED)
NEW / RETROFIT	RETROFIT
START-UP DATE	JUNE, 1980
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	90% (1,800 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	99.5%
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL FLYASH ADDITION TO DEWATERED CASO3/CASO4 FILTER CAKE, THEN TO LANDFILL.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

ARCO/POLYMERS, BEAVER VALLEY PLANT LOCATED NEAR MONACA, PENNSYLVANIA, AWARDED A CONTRACT IN JUNE 1978 TO FMC TO INSTALL THREE FOUR-STAGE DISC CONTACTOR SCRUBBERS. THE SYSTEM WILL UTILIZE THE FMC DOUBLE ALKALI PROCESS WITH THE SCRUBBERS SHARING A COMMON REGENERATION UNIT.

THREE BOILERS GENERATE PROCESS STEAM USED TO OPERATE A TURBINE WHICH GENERATES 18 TO 20 KVA (CAPACITY 35 KVA). THE STEAM RATE FOR EACH BOILER IS 300,000 LB/HR @ 700 PSIG AND 700 F. TOTAL HEAT INPUT IS 1100 MM BTU/HR. PULVERIZED COAL (3.0% SULFUR) IS THE FUEL USED WITH AN ASH CONTENT OF 15%. IT HAS A HEAT VALUE OF 12,000 BTU/LB @ 4-6% MOISTURE CONTENT. THE COST FOR THE COAL IS $8.84/TON.

KOPPERS ESP'S PRECLEAN THE FLUE GAS BEFORE IT ENTERS THE SCRUBBERS AT A RATE OF 165,000 ACFM (EACH) @ 400 F. THE INLET CONCENTRATION OF PARTICULATES TO THE ESP S IS 5 GR/SCF. GAS ENTERING THE SCRUBBERS WILL HAVE AN SO2 CONCENTRATION OF APPROXIMATELY 1800 PPM. THE SCRUBBERS (17 FT DIA X 62 FT HEIGHT) WITH 4 DISCS AND DONUTS (EACH) WILL BE CONSTRUCTED OF CARBON STEEL WITH CEILCOTE LININGS (FLAKED GLASS LINING) AND THE MIST ELIMINATORS (1 FOR EACH SCRUBBER) ARE SINGLE STAGE CHEVRON PAD TYPE CONSTRUCTED OF PVC PLASTIC WITH PROVISIONS FOR A SECOND STAGE. EACH SCRUBBER WILL EXHAUST TO INDIVIDUAL INSULATED STACKS LINED WITH FRP. ASSOCIATED WITH EACH STACK IS A REHEATER USING

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

ARCO/POLYMERS, INC.: MONACA, PENNSYLVANIA (CONTINUED)

STEAM HEATED AMBIENT AIR. THE SCRUBBERS WILL HANDLE 100% OF THE FLUE GASES WITH BY-PASS ONLY AVAILABLE FOR EMERGENCIES. THE L/G RATIO FOR THE SCRUBBERS IS APPROXIMATELY 10. THE WESTINGHOUSE F.D. FANS WILL BE OF CARBON STEEL AND PUMPS OF RUBBER-LINED CARBON STEEL. THE DUCTING LEADING TO AND FROM THE SCRUBBERS WILL BE OF FIBERGLASS LINED (CEILCOTE) CARBON STEEL AND FRP, RESPECTIVELY.

CALCIUM SULFATE WASTE WILL BE HAULED BY TRUCK TO A DISPOSAL SITE.

REFER TO FIGURE 14-3 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1978	CONSTRUCTION IS TO BEGIN IN SEPTEMBER 1978.
4TH QUARTER-1978	CONSTRUCTION OF THE PLANNED FGD SYSTEM STARTED IN SEPTEMBER 1978.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	BELRIDGE OIL CO.
INSTALLATION LOCATION	MCKITTRICK, CALIFORNIA
SOURCE CHARACTERISTICS	CRUDE OIL (1.1% SULFUR)
SOURCE RATING	12,000 SCFM 24,000 ACFM @ 570 F
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	5 MW (EQUIVALENT) 50 MM BTU/HR (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	C-E NATCO
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	JANUARY, 1979
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	90% (500 PPM SO2 @ INLET)
WATER MAKE-UP	15 GPM
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

BELRIDGE OIL COMPANY HAS AN ENHANCED OIL RECOVERY SITE IN MCKITTRICK, CALIFORNIA. THE SITE IS LOCATED IN WESTERN KERN COUNTY AND HAS SEVERAL SMALL STEAM GENERATORS RATED AT 50 AND 25 MM BTU/HR. THE CRUDE OIL HAS 1.1 PERCENT SULFUR CONTENT.

IN VIEW OF THE NEW REGULATIONS OF THE CALIFORNIA AIR RESOURCE BOARD (CARB), BELRIDGE HAS UNDERTAKEN A PROGRAM TO EVALUATE THE COMMERCIALLY AVAILABLE FGD TECHNOLOGY FOR APPLICATIONS TO A SMALL (TYPICALLY 50 MM BTU/HR) STEAM GENERATOR. THEY HAVE ALREADY INSTALLED TWO FGD SYSTEMS SUPPLIED BY HEATER TECHNOLOGY AND THERMOTICS. (SEE SECTION 9 OF THIS REPORT FOR DESCRIPTIONS OF THESE SYSTEMS). A THIRD SYSTEM, BEING SUPPLIED BY C-E NATCO, IS UNDER CONSTRUCTION. C-E NATCO, A SUBSIDIARY OF COMBUSTION ENGINEERING, IS THE PRINCIPAL SUPPLIER OF THE STEAM GENERATORS TO THE OIL FIELDS. THE FGD SYSTEM IS SCHEDULED TO GO ONSTREAM BY EARLY JANUARY 19[illegible].

THE FLUE GAS (29,000 ACFM AT 570 F) IS QUENCHED BY A SET OF SPRAYS IN THE BOTTOM PART OF THE ABSORBER (7 FEET DIA X 35 FEET HIGH). THE QUENCHER SECTION HAS A SEPARATE RECIRCULATION PUMP (300 GPM) WHICH ALSO BLEEDS OFF A PURGE STREAM (10 GPM). THE PH IN THIS STAGE IS RANGES FROM 6-6.5. THE COOLED GAS PASSES THROUGH A "CHIMNEY-TRAY" (TRAY WITH A CENTRAL DOWNCOMER) AND IS FURTHER CONTACTED WITH LIQUOR SPRAYS (PH BETWEEN 7.5-8.0). THE ABSORPTION STAGE HAS A SEPARATE RECIRCULATION PUMP (300 GPM) WHICH ALSO RECEIVES A CONTINUOUS STREAM OF FRESH SODIUM CARBONATE SOLUTION (15 GPM). THE FLUE GAS PASSES THROUGH A CHEVRON MIST ELIMINATOR AND A STUB STACK AT THE

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

BELRIDGE OIL CO.; MCKITTRICK, CALIFORNIA (CONTINUED)

TOP OF THE ABSORBER.

THE ABSORBER, TRAY, RECIRCULATION PUMPS, PIPING, AND STACK ARE MADE OF 316L SS. THE SODA ASH MIX TANK, FEED PUMP AND PIPING ARE CARBON STEEL, AND THE MIST ELIMINATOR IS FRP.

OPERATING HISTORY

4TH QUARTER-1978 THE SYSTEM IS UNDER CONSTRUCTION AND THE STARTUP DATE IS DELAYED TO EARLY JANUARY 1979 FROM NOVEMBER 1978.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CATERPILLAR TRACTOR CO.
INSTALLATION LOCATION	MAPLETON, ILLINOIS
SOURCE CHARACTERISTICS	COAL (3.2% SULFUR)
SOURCE RATING	131,000 SCFM (TOTAL - 3 BOILERS)
	80,000 ACFM @ 350 F, FOR EACH OF 2 FGD SYSTEMS
	40,000 ACFM @ 350 F, FOR 1 FGD SYSTEM
	600,000 LB/HR STEAM (TOTAL - 3 BOILERS)
NUMBER OF SEPARATE FGD UNITS	3
NUMBER OF BOILERS BEING CONTROLLED	3
SOURCE CAPACITY	65 MW (EQUIVALENT); TOTAL - 3 BOILERS
	(FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	DOUBLE ALKALI (CONCENTRATED)
NEW / RETROFIT	NEW
START-UP DATE	JANUARY, 1979
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	90% (2000 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL
	60+% SOLIDS (CASO4) SLUDGE DIRECTLY TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

AT THE MAPLETON, ILLINOIS PLANT, CATERPILLAR TRACTOR IS INSTALLING FIVE NEW BOILERS, THREE OF WHICH ARE SLATED TO BEGIN OPERATIONS DURING JANUARY 1979. THE OTHER TWO WILL BEGIN OPERATIONS IN THE EARLY 1980'S. BECAUSE CONSTRUCTION HAS NOT YET BEGUN ON THESE TWO FGD SYSTEMS THEY ARE REPORTED IN SECTION 11 OF THIS REPORT. TWO BOILERS STARTING IN JANUARY 1979 ARE RATED AT 250,000 LB/HR STEAM EACH, THE OTHER IS RATED AT 100,000 LB/HR STEAM. BOTH BOILERS STARTING IN THE EARLY 1980'S WILL BE 1,100,000 LB/HR.

CATERPILLAR HAS AWARDED A CONTRACT TO FMC ENVIRONMENTAL EQUIPMENT TO PROVIDE CONCENTRATED MODE DUAL ALKALI FGD SYSTEMS FOR ALL FIVE BOILERS. EACH BOILER WILL HAVE A SEPARATE FGD SYSTEM. EACH SYSTEM WILL INCLUDE A VENTURI SCRUBBER FOLLOWED BY A CYCLONIC MIST ELIMINATOR.

FACILITIES FOR REGENERATION, SLUDGE HANDLING AND DISPOSAL WILL BE SHARED BY ALL FIVE BOILERS. THE SAME FACILITIES HAVE BEEN DESIGNED TO HANDLE A TOTAL OF EIGHT BOILERS. THE ADDITIONAL CAPACITY FOR THREE BOILERS WAS PLANNED FOR PROBABLE PLANT EXPANSION IN THE FUTURE. THERE IS NO PLANNED START-UP DATE FOR THESE THREE BOILERS.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

CATERPILLAR TRACTOR CO.: MAPLETON, ILLINOIS (CONTINUED)

OPERATING HISTORY

3RD QUARTER-1977 SYSTEM WAS UNDER CONSTRUCTION. START-UP WAS EXPECTED LATE IN THE FALL OF 1977.

4TH QUARTER-1977 CONSTRUCTION DELAYS ON THE STEAM GENERATION SIDE PUSHED PLANT START-UP BACK TO THE FALL OF 1978.

2ND QUARTER-1978 START-UP WAS STILL PLANNED FOR THE 1978-1979 HEATING SEASON. THREE BOILERS AND THEIR INDIVIDUAL FMC FGD SYSTEMS WILL COME ON-LINE AT THAT TIME.

3RD QUARTER-1978 CONSTRUCTION WAS NEARING COMPLETION. SPECIAL MODIFICATIONS WERE BEING MADE WHICH WERE DELAYING START-UP. EXPERIENCE GAINED AT MOSSVILLE IS BEING APPLIED TO MAPLETON SINCE THE SYSTEMS ARE SIMILAR.

4TH QUARTER-1978 DELAYS OF THE START-UP DATE FOR THE THREE BOILERS AND THEIR RELATED FGD SYSTEMS ACTIVITIES AND NOT THE INSTALLATION OF SPECIAL MODIFICATIONS. CONSTRUCTION OF THESE THREE BOILERS HAS BEEN COMPLETED; START-UP IS EXPECTED AT THE END OF DECEMBER OR BEGINNING OF JANUARY. INSTALLATION HAS JUST BEGUN ON THE OTHER TWO 250,000 LB/HR BOILERS. START-UP FOR THESE TWO BOILERS WILL BE IN THE EARLY 1980'S.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CHANSLOR WESTERN OIL & DEV. CO
INSTALLATION LOCATION	BAKERSFIELD, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.5% SULFUR)
SOURCE RATING	70,000 SCFM (TOTAL - 8 BOILERS)
	310 MM BTU/HR (TOTAL - 8 BOILERS)
	133,400 ACFM @ 550 F (TOTAL - 8 BOILERS)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	8
SOURCE CAPACITY	35 MW (EQUIVALENT); TOTAL - 8 STEAM GENERATORS
	(FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	DOUBLE ALKALI (CONCENTRATED)
NEW / RETROFIT	NEW
START-UP DATE	MARCH, 1979
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	96% (710 PPM @ INLET)
WATER MAKE-UP	71 GPM
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL
	SALTS IS THEREBY PREVENTED.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

OPERATING HISTORY

CHANSLOR WESTERN OIL COMPANY HAS AN ENHANCED OIL RECOVERY SITE NEAR BAKERSFIELD, CALIFORNIA. THE OIL PRODUCTION INVOLVES INJECTION OF STEAM IN THE OIL WELLS, DECANTATION OF OIL FROM OIL-WATER MIXTURE, AND PURIFICATION OF OIL IF NECESSARY. THE CRUDE OIL PRODUCED BY THIS PROCESS HAS APPROXIMATELY 1.5% SULFUR. A PART OF THE OIL PRODUCED IS USED AS A FUEL FOR THE BOILERS WHICH GENERATE THE NECESSARY PROCESS STEAM. THERE ARE SEVERAL BOILERS ON THE SITE, MANY OF WHICH ARE RATED AT 50 MM BTU/HR. THE BOILERS ARE CLASSIFIED AS "STEAM GENERATORS" BECAUSE OF THEIR SIZE, PORTABLE NATURE, AND LOWER QUALITY OF STEAM (80%) PRODUCED.

EIGHT OF THE STEAM GENERATORS, WITH A TOTAL HEAT OUTPUT OF 310 MM BTU/HR, ARE BEING CONSTRUCTED ALONG WITH A NEW, FMC DOUBLE-ALKALI (CONCENTRATED) FGD SYSTEM. THE FLUE GASES FROM THE EIGHT STEAM GENERATORS ARE MANIFOLDED TOGETHER (133,400 ACFM @ 550 F), AND PASS THROUGH A PRESATURATOR AND AN ABSORBER (15' DIAMETER BY 35' HIGH) WITH 4 DISC-AND-DONUT TRAYS. THE RECIRCULATION LIQUOR PH IS MAINTAINED AT 6.5, AND A L/G RATIO IS USED. THE FLUE GASES PASS THROUGH A CHEVRON MIST ELIMINATOR TO A STACK. A CONSTANT BLEED-OFF STREAM (60 GPM) IS TAKEN TO THE REACTION TANK WHERE IT REACTS WITH LIME SLURRY TO REGENERATE SODIUM HYDROXIDE. THE CALCIUM SULFITE/SULFATE SLURRY IS SENT TO THE THICKENER, VACUUM FILTER AND LANDFILL.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

CHANSLOR WESTERN OIL & DEV. CO; BAKERSFIELD, CALIFORNIA (CONTINUED)

REFER TO FIGURE 14-11 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1978 THE PLANT IS NEARING COMPLETION OF CONSTRUCTION. THE COMMISIONING ACTIVITIES WILL BE UNDERWAY SOON.

4TH QUARTER-1978 CONSTRUCTION WORK HAS BEEN HELD UP PRIMARILY DUE TO DELAYS IN SHIPMENT OF ELECTRIC CONNECTIONS AND EQUIPMENT.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GETTY OIL COMPANY
INSTALLATION LOCATION	BAKERSFIELD, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.1% SULFUR)
SOURCE RATING	396,000 SCFM (TOTAL-36 BOILERS) 4 FGD SYSTEMS, EACH TREATING 200,000 ACFM @ 500 F
NUMBER OF SEPARATE FGD UNITS	4
NUMBER OF BOILERS BEING CONTROLLED	36
SOURCE CAPACITY	200 MW (EQUIVALENT); 1800 MM BTU/HR (TOTAL-36 BOILERS) EACH BOILER RATED AT 42,000 LBS/HR STEAM (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	IN-HOUSE DESIGN
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	JANUARY, 1979
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	96% (600 PPM SO2 @ INLET)
PARTICULATE REMOVAL EFFICIENCY	50% (35 LB/HR ASH @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO TAILINGS POND HOLDING POND FOR EVAPORATION. 9 GPM BLEEDOFF TO A BLOWDOWN TANK. THE BLOWDOWN IS EMPTIED INTO A DISPOSAL POND ONCE A WEEK.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	MOBIL OIL COMPANY
INSTALLATION LOCATION	BUTTONWILLOW, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.1% SULFUR)
SOURCE RATING	80,500 SCFM (TOTAL - 7 BOILERS) 7 FGD SYSTEMS, EACH TREATING 22,000 ACFM @ 550F.
NUMBER OF SEPARATE FGD UNITS	7
NUMBER OF BOILERS BEING CONTROLLED	7
SOURCE CAPACITY	40 MW (EQUIVALENT); 350 MM BTU/HR (TOTAL - 7 BOILERS) (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.
CONTROL SYSTEM VENDOR	HEATER TECHNOLOGY
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	FEBRUARY, 1979
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	85% (500 PPM @ INLET)
WATER MAKE-UP	15 GPM; OIL FIELD WASTE WATER
SLUDGE OR BY-PRODUCT DISPOSAL	HOLDING POND FOR EVAPORATION INTERMITTENT BLOWDOWN TO WASTE DISPOSAL SITE.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

MOBIL OIL COMPANY HAS AN ENHANCED OIL RECOVERY SITE AT BUTTONWILLOW, CALIFORNIA. THE OPERATION REQUIRES PROCESS STEAM WHICH IS SUPPLIED BY SEVERAL STEAM GENERATIONS RATED AT 50 MM BTU/HR. MOBIL HAS BEEN OPERATING SEVERAL FGD SYSTEMS AT THE SAN ARDO OIL SITE SINCE 1974. (SEE SECTION 9 OF THIS REPORT FOR DETAILS ON THESE SYSTEMS).

HEATER TECHNOLOGY HAS RETROFITTED 7 FGD SYSTEMS AT BUTTONWILLOW IN OCTOBER, 1978. EACH SYSTEM TREATS FLUE GAS FROM ONE GENERATOR (22,000 ACFM @ 550 F). THE PROCESS USED IS SODIUM CARBONATE SCRUBBING. THE SYSTEM INCLUDES AN EDUCTOR-ABSORBER, A RECYCLE TANK, A MIST ELIMINATOR, AND A STUB STACK. THE EDUCTOR HAS AN ADJUSTABLE DISK WHICH FORMS THE CONTACT STAGE FOR THE GAS AND RECIRCULATING LIQUOR. THE RECIRCULATION PH IS SET AT ABOUT 8.0 AND A L/G RATIO OF 40 GAL/1000 ACF IS USED. FRESH SODIUM CARBONATE SOLUTION IS ADDED TO THE RECYCLE TANK (15 GPM), AND A BLEED-OFF STEAM IS TAKEN TO HOLDING POND (10 GPM).

THE EDUCTOR, CONTACTING DISC, RECICULATION PIPING AND THE PUMP ARE MADE OF 316 SS. THE RECYCLE TANK IS CARBON STEEL WITH EPOXY TAR COATING AND THE CHEVRON-TYPE MIST ELIMINATOR IS FRP.

REFER TO FIGURE 14-35 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

MOBIL OIL COMPANY: BUTTONWILLOW, CALIFORNIA (CONTINUED)

OPERATING HISTORY

4TH QUARTER-1978 THE START-UP DATE HAS BEEN EXTENDED TO FEBRUARY OF 1979, DUE TO DELAYS IN AWARDING SEPARATE CONTRACTS FOR PIPING AND OTHER WORK.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	PHILLIP MORRIS, INC.
INSTALLATION LOCATION	CHESTERFIELD, VIRGINIA
SOURCE CHARACTERISTICS	COAL
SOURCE RATING	39,000 SCFM (TOTAL - 1 BOILER) 55,000 ACFM @ 350F, 200,000 LB/HR STEAM
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	20 MW (EQUIVALENT); 237 MM BTU/HR (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	FLAKT, INC.
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	JUNE, 1979
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	90% (DESIGN MINIMUM)
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

PHILIP MORRIS, INC. IS CURRENTLY EXPANDING THEIR TOBACCO REPROCESSING PLANT AT CHESTERFIELD, VIRGINIA. THE PLANT EXPANSION, WHICH IS BEING HANDLED BY AUSTIN PROCESSES, INC., INCLUDES THE ADDITION OF A 237 MM BTU/HR BABCOCK AND WILCOX PULVERIZED COAL-FIRED BOILER AND AN EMISSIONS CONTROL SYSTEM FROM FLAKT, INC. THE BOILER FLUE GAS (88,900 ACFM @ 350 F) WILL FIRST PASS THROUGH A COLD-SIDE ESP WITH A GUARANTEED MINIMUM COLLECTION EFFICIENCY OF 99.6%. THE FGD SYSTEM IS DESIGNED TO HANDLE TWO-THIRDS OF THE GAS DISCHARGED FROM THE PRECIPITATOR WITH A MINIMUM SO2 REMOVAL EFFICIENCY OF 90%. THE REMAINING ONE-THIRD OF THE GAS WILL BE USED FOR REHEAT.

FLUE GASES ENTERING THE SCRUBBER ARE FIRST COOLED AND SATURATED IN A PREQUENCHER BY A 6 GPM SPRAY OF FRESH WATER. THE ABSORBER ITSELF IS A 3-STAGE SPRAY TOWER (9 FT. DIA. X 35 FT. HIGH) UTILIZING SODIUM CARBONATE SCRUBBING AND OPERATING AT 130 F WITH AN L/G RATIO OF 18 GAL/ACF. THE DESIGN INLET PH IS 7.5. PRESSURE DROP ACROSS THE SCRUBBER IS EXPECTED TO BE ABOUT 2.5 IN. W.G. FOLLOWING THE ABSORBER THE FLUE GASES FLOW THROUGH A 3-PASS CHEVRON MIST ELIMINATOR BEFORE JOINING WITH THE REHEAT GAS IN A MIX CHAMBER. THE STACK IS DUAL-WALL CORTEN STEEL-LINED, 5.5 FT. IN DIAMETER X 185 FT. HIGH. A BLEED STREAM OF 5 - 11 GPM IS TAKEN FROM THE RECIRCULATION LINE JUST DOWNSTREAM OF THE PUMP. THIS STREAM, WITH A PH OF ABOUT 6.5, GOES TO AN AERATION TANK WHERE ANY SULFITE IS CONVERTED TO SULFATE. FINAL DISPOSAL OF THE SODIUM SULFATE SLUDGE HAS NOT BEEN DETERMINED, AS PHILIP MORRIS PLANS TO EXPERIMENT WITH VARIOUS METHODS. MAKE-UP SODIUM CARBONATE SOLUTION IS ADDED IN THE RECIRCULATION LINE JUST DOWNSTREAM OF THE BLEEDOFF. THE MAKE-UP SOLUTION IS STORED IN A CARBON STEEL SODA ASH MIX TANK, 12 FT. IN DIAMETER X 22 FT. HIGH. THE SPRAY TOWER IS

PHILLIP MORRIS, INC.: CHESTERFIELD, VIRGINIA (CONTINUED)

MADE OF FRP AND THE NOZZLES (6 PER STAGE) ARE 316 STAINLESS STEEL. ALL PUMPS ARE RUBBER-LINED. RECIRCULATION LINES ARE 316 SS AND THE MIST ELIMINATOR IS POLYPROPYLENE.

REFER TO FIGURE 14-38 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	ST. JOE ZINC CO.
INSTALLATION LOCATION	MONACA, PENNSYLVANIA
SOURCE CHARACTERISTICS	COAL (2.5% - 4.5% SULFUR)
SOURCE RATING	142,000 SCFM (TOTAL - 1 BOILER)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	60 MW (ELECTRIC POWER: NOMINAL PEAK CAPACITY) (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT M THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.
CONTROL SYSTEM VENDOR	BUREAU OF MINES
CONTROL PROCESS	CITRATE PROCESS
NEW / RETROFIT	RETROFIT
START-UP DATE	MARCH, 1979
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	90+%
SLUDGE OR BY-PRODUCT DISPOSAL	REGENERABLE - ELEMENTAL SULFUR PRODUCT
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

IN THE SUMMER OF 1977, CONSTRUCTION BEGAN AT MONACA, PA. ON A CITRATE PROCESS (BUREAU OF MINES) FGD SYSTEM FOR ONE OF THE TWO 60-MW (NOMINAL PEAK CAPACITY) BOILERS OF THE GEORGE F. WEATON POWER PLANT USED BY ST. JOE ZINC CO. TO GENERATE ELECTRICITY FOR A ZINC SMELTER. ST. JOE HAS A RECIPROCAL AGREEMENT WITH THE LOCAL UTILITY COMPANY, DUQUESNE LIGHT, WHEREBY ST. JOE CAN SELL UP TO 25-MW OF ITS TOTAL 120-MW CAPACITY TO DUQUESNE. IN RETURN, ST. JOE CAN BUY SUFFICIENT POWER TO MAINTAIN ELECTRO-SMELTING OPERATIONS IN THE EVENT OF AN EMERGENCY. THIS FGD SYSTEM IS THE FIRST SMALL COMMERCIAL SIZE EXPERIMENTAL CITRATE CONTROL SYSTEM BEING BUILT FOR REMOVING SULFUR DIOXIDE FROM COAL-FIRED POWER PLANT STACK GAS.

UNDER A $12.7 MILLION COST-SHARING AGREEMENT BETWEEN THE BUREAU AND ST. JOE, COSTS FOR TESTING THE CITRATE PROCESS FOR A FULL YEAR ARE BEING SHARED ABOUT 50-50. THE CITRATE PROCESS WAS DEVELOPED BY THE BUREAU IN THE 1960'S TO HELP CURB SULFUR DIOXIDE EMISSIONS FROM BASE METAL SMELTERS.

THE CITRATE PROCESS DERIVES ITS NAME FROM THE WATER SOLUTION OF SODIUM CITRATE AND CITRIC ACID USED AS A BUFFERING AGENT DURING SO2 ABSORPTION FROM THE FLUE GAS. THE CITRATE PROCESS IS DESIGNED TO TREAT 234,000 ACFM @ 300 F FLUE GAS GENERATED BY FIRING PULVERIZED COAL POSSESSING 2.5-4.5% SULFUR, 15% ASH AND AN HHV OF APPROXIMATELY 12,500 BTU/LB. THE PLANT WILL MEET THE PENNSYLVANIA AIR QUALITY REGULATION OF 0.695 LBS OF SO2 PER MILLION BTU HEAT INPUT TO THE BOILER.

THE DEMONSTRATION PLANT, DESIGNED WITH A 60% TURNDOWN RATIO, UTILIZES A SINGLE PROCESS TRAIN CONSISTING OF GAS COOLING AND SO2 ABSORPTION, SULFUR PRECIPITATION, SULFUR RECOVERY, SODIUM SULFATE REMOVAL, AND H2S GENERATION UNIT OPERATIONS. FLUE GAS FROM AN EXISTING PRECIPITATOR ENTERS AN

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

ST. JOE ZINC CO.; MONACA, PENNSYLVANIA (CONTINUED)

EDUCTOR TYPE VENTURI SCRUBBER, THROUGH AN F.D. FAN WHERE IT IS COOLED FROM 300 F TO 120 F BY BOTH HUMIDIFICATION AND SENSIBLE COOLING. A BLEED STREAM IS TAKEN FROM THE VENTURI RECYCLE STREAM TO PREVENT BUILD-UP OF ASH AND ACIDS. THIS STREAM FLOWS THROUGH A PACKED COLUMN COUNTERCURRENT TO A STREAM OF AIR WHERE SO_2 IS STRIPPED FROM THE LIQUID AND RECYCLED TO THE SCRUBBER. THE STRIPPED LIQUID IS DISCHARGED TO AN AGITATOR TANK WHERE IT IS NEUTRALIZED WITH LIME. FROM THERE, IT IS PUMPED TO THE EXISTING ASH POND.

THE COOLED, CLEANED FLUE GAS THEN ENTERS A PACKED ABSORBER (26 FT DIA X 85 FT HIGH) MADE OF FLAKE-GLASS LINED, CARBON STEEL, WHERE IT FLOWS UPWARD COUNTERCURRENT TO THE DESCENDING CITRATE SOLUTION. MORE THAN 90% OF THE SO_2 IS REMOVED FROM THE FLUE GAS, MAINLY AS SULFUROUS ACID, IN THE PRESENCE OF THE CITRATE BUFFER SOLUTION. CITRATE SOLUTION LEAVING THE ABSORBER FLOWS IN SERIES THROUGH TWO TANDEM REACTORS IN THE SULFUR RECOVERY SECTION. THE CITRATE RECYCLE STREAM FROM THE REGENERATION SECTION IS COOLED FROM 131 F TO 123 F BY HEAT EXCHANGE WITH RIVER WATER BEFORE ENTERING THE ABSORBER.

SULFUR IS FORMED BY CONTACTING THE SO_2-RICH SOLUTION WITH AN H_2S-CO_2 GAS FROM THE HYDROGEN SULFIDE GENERATING UNIT. OFF-GAS WHICH IS MAINLY CO_2 WITH SMALL QUALITIES OF H_2S, CS_2, AND COS FROM THE REACTOR SYSTEM IS SENT TO THE BOILER FIREBOX FOR INCINERATION VIA A SURGE DRUM. CRYSTALLINE SULFUR IS FORMED IN THE REACTORS AND SULFUR SLURRY FLOWS TO A DIGESTER WHERE A SMALL STREAM OF SO_2-RICH SOLUTION FROM THE ABSORBER IS REACTED WITH ANY DISSOLVED OR ENTRAINED H_2S IN THE SLURRY ENTERING THE DIGESTER. FROM THE DIGESTER, THE SLURRY FLOWS TO THE SULFUR FLOTATION TANK. SEPARATION OF THE SULFUR FROM THE BULK OF THE SOLUTION IS ACCOMPLISHED BY FLOTATION WITH AIR. SULFUR FROTH, CONCENTRATED TO ABOUT 10% SOLIDS, IS SEPARATED FROM THE TOP OF THE SOLUTION AND FLOWS TO THE SULFUR SLURRY TANK.

REGENERATED CITRATE SOLUTION IS DRAWN FROM THE BOTTOM OF THE FLOTATION TANK AND RETURNED TO THE ABSORBER. SULFUR IS SEPARATED FROM THE REMAINING SOLUTION BY HEATING THE SLURRY TO ABOUT 260 F WITH STEAM IN A SHELL-AND-TUBE EXCHANGER. THE MOLTEN SULFUR AND THE CITRATE SOLUTION ARE SEPARATED BY GRAVITY IN A PRESSURIZED, STEAM-JACKETED DECANTER VESSEL. THE MOLTEN SULFUR IS DISCHARGED CONTINUOUSLY FROM THE BOTTOM BY INTERFACE LEVEL CONTROL AND FLOWS TO A HEATED STORAGE TANK. THE CITRATE SOLUTION LEAVES THE TOP OF THE DECANTER AND RETURNS TO THE FIRST REACTOR.

SODIUM SULFATE DECAHYDRATE, PRODUCED BY THE NEUTRALIZATION OF CAUSTIC WITH A SMALL AMOUNT OF GENERATED SULFURIC ACID, IS REMOVED FROM CITRATE SOLUTION BY VACUUM CRYSTALLIZATION.

GENERATION OF H_2S GAS IS ACCOMPLISHED USING RECOVERED ELEMENTAL SULFUR, A GASEOUS REDUCTANT (METHANE) AND TURBINE EXTRACTION STEAM AS CONSUMPTIVE FEED STOCKS IN A FIXED-BED CATALYTIC REACTOR. REFER TO FIGURE 14-41 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1978 ALL MAJOR EQUIPMENT HAS BEEN INSTALLED; INSTALLATION OF PIPING AND WIRING IS IN

ST. JOE ZINC CO.; MONACA, PENNSYLVANIA (CONTINUED)

PROGRESS.

4TH QUARTER-1978 THE PLANT REPORTED THAT INSTALLATION OF PIPING AND WIRING IS STILL IN PROGRESS. START-UP HAS BEEN RESCHEDULED FOR MARCH 1979.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	SUN PRODUCTION COMPANY
INSTALLATION LOCATION	FELLOWS, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.4% SULFUR)
SOURCE RATING	6,000 SCFM (12,000 ACFM @ 570 F)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
CONTROL SYSTEM VENDOR	C-E NATCO
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	APRIL, 1979
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	85% (800 PPM @ INLET)
WATER MAKE-UP	4 GPM
SLUDGE OR BY-PRODUCT DISPOSAL	HOLDING POND FOR EVAPORATION
	1 GPM BLEEDOFF TO DISPOSAL POND
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

SUN PRODUCTION COMPANY HAS AN ENHANCED OIL RECOVERY SITE NEAR FELLOWS, CALIFORNIA. SEVERAL STEAM GENERATORS ARE USED TO PRODUCE THE PROCESS STEAM REQUIRED FOR THE OPERATION. A PART OF OIL, WHICH HAS A 1.4 PERCENT SULFUR, IS USED AS FUEL.

C-E NATCO HAS BEEN AWARDED A CONTRACT TO INSTALL AN FGD SYSTEM ON ONE 25 MM BTU/HOUR STEAM GENERATOR. NO FGD SYSTEM TREATS 12,000 ACFM FLUE GAS AT 570 F. THE FLUE GAS IS CONTACTED WITH ONE SET OF SPRAYS (150 GPM) IN THE BOTTOM OF THE ABSORBER (4.5' DIAMETER X 35 FT HIGH). PH OF 6.5 IS MAINTAINED IN THE FIRST STAGE. THE GAS WHICH PASSES UP A TRAY WITH A CENTRAL DOWNCOMER, IS FURTHER CONTACTED WITH A SECOND SET OF SPRAYS (150 GPM). A CHEVRON MIST ELIMINATOR (INCOLOY 825) LEADS INTO A STUB STACK. THE EXCESS LIQUOR FROM THE TRAY OVERFLOWS TO THE FIRST STAGE. PH IS MAINTAINED AT 7.5 IN THE SECOND STAGE. MAKEUP SODIUM HYDROXIDE SOLUTION (0.05 GPM) IS ADDED TO THE SECOND STAGE BY A POSITIVE DISPLACEMENT PUMP WHILE FRESH MAKEUP WATER (4 GPM) IS ADDED TO THE FIRST STAGE. A BLEEDOFF (1 GPM) STREAM IS TAKEN TO WASTE DISPOSAL FROM THE FIRST STAGE RECIRCULATION LINE.

THE ABSORBER, MIST ELIMINATOR, RECIRCULATION PUMPS AND PIPING, AND THE SPRAY HEADERS ARE 316L SS. THE CAUSTIC FEED PUMP AND THE PIPING AND THE INLET DUCTWORK IS C.S.

OPERATING HISTORY

4TH QUARTER-1978 THE SYSTEM IS UNDER CONSTRUCTION. THE STARTUP IS EXPECTED BY APRIL 1979.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	SUN PRODUCTION COMPANY
INSTALLATION LOCATION	OILDALE, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.2% SULFUR)
SOURCE RATING	6,000 SCFM (12,000 ACFM @ 570 F)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	1
CONTROL SYSTEM VENDOR	C-E NATCO
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	APRIL, 1979
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	85% (700 PPM @ INLET)
WATER MAKE-UP	4 GPM
SLUDGE OR BY-PRODUCT DISPOSAL	HOLDING POND FOR EVAPORATION 1 GPM BLEEDOFF TO DISPOSAL POND
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

SUN PRODUCTION CO. HAS AN ENHANCED OIL RECOVERY SITE NEAR OILDALE, CALIFORNIA. SEVERAL SMALL GENERATORS ARE USED TO PRODUCE THE PROCESS STEAM REQUIRED FOR THE OPERATION. A PART OF THE OIL, WHICH HAS 1.2 PERCENT SULFUR, IS USED AS FUEL.

C-E NATCO HAS BEEN AWARDED A CONTRACT TO INSTALL AN FGD SYSTEM ON ONE 25 MM BTU/HOUR STEAM GENERATOR. NO FGD SYSTEM TREATS 12,000 ACFM FLUE GAS AT 570 F. THE FLUE GAS IS CONTACTED WITH ONE SET OF SPRAYS (150 GPM) IN THE BOTTOM OF THE ABSORBER (4.5 FT DIAMETER X 35 FT HIGH). PH OF 6.5 IS MAINTAINED IN THE FIRST STAGE. THE GAS, WHICH PASSES UP A TRAY WITH A CENTRAL DOWNCOMER, IS FURTHER CONTACTED WITH A SECOND SET OF SPRAYS (150 GPM). THE GAS PASSES UP A CHEVRON MIST ELIMINATOR INTO A STUB STACK. THE EXCESS LIQUOR FROM THE TRAY OVERFLOWS TO THE FIRST STAGE. A PH OF 7.5 IS MAINTAINED IN THE SECOND STAGE. MAKEUP SODIUM HYDROXIDE SOLUTION (0.05 GPM) IS ADDED TO THE SECOND STAGE BY A POSITIVE DISPLACEMENT PUMP WHILE FRESH MAKEUP WATER (4 GPM) IS ADDED TO THE FIRST STAGE. A BLEED OFF (1 GPM) STREAM IS TAKEN TO WASTE DISPOSAL FROM THE FIRST STAGE RECIRCULATION LINE.

THE ABSORBER, MIST ELIMINATOR, RECIRCULATION PUMPS AND PIPING, AND SPRAY HEADERS ARE 316L SS. THE CAUSTIC FEED PUMP AND THE PIPING AND THE INLET DUCTWORK ARE C.S.

SECTION 10 (CONTINUED)

DESIGN INFORMATION FOR UNDER CONSTRUCTION FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	TEXACO INCORPORATED
INSTALLATION LOCATION	SAN ARDO, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.7% SULFUR)
SOURCE RATING	117,000 SCFM (TOTAL - 9 BOILERS) 26,000 ACFM @ 600 F, FOR EACH OF 9 BOILERS.
NUMBER OF SEPARATE FGD UNITS	3
NUMBER OF BOILERS BEING CONTROLLED	9
SOURCE CAPACITY	58 MW (EQUIVALENT); 50 MM BTU/HR/BOILER (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	DUCON COMPANY
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	MARCH, 1979
CONTROL SYSTEM STATUS	CONSTRUCTION
SO2 REMOVAL EFFICIENCY	95% (1000 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	SCRUBBER EFFLUENT DISPOSED OF IN WASTE WELLS
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

TEXACO HAS CHOSEN TO PHASE OUT THE EXISTING CEILCOTE SCRUBBER SYSTEMS AT SAN ARDO OIL FIELDS DUE TO LOW SO2 REMOVAL AND HIGH MAINTAINENCE COST. A MAJOR PROBLEM OF THE PRESENT DESIGN HAS BEEN SCRUBBER FOULING BECAUSE OF HIGH ASH CONTENT IN THE FLUE GAS. AS THE FIRST STEP OF THE PHASE-OUT PROGRAM, 9 OF THE PRESENT CEILCOTE SCRUBBERS ON THE 50 MM BTU/HR STEAM GENERATORS WILL BE REPLACED BY 3 DUCON CO. SCRUBBERS HEADERED IN PARALLEL. START-UP OF THE NEW EQUIPMENT IS SCHEDULED FOR MARCH 1979. THE NEXT STEP OF THE PHASE-OUT PROGRAM IS DEPENDENT ON THE PERFORMANCE OF THE DUCON SYSTEM. (FOR INFORMATION ON THE CEILCOTE DESIGN SEE THE TEXACO, SAN ARDO ENTRY IN SECTION 9 OF THIS REPORT).

EACH DUCON SCRUBBING UNIT WILL CONSIST OF A VENTURI FOR PARTICULATE REMOVAL FOLLOWED BY A HORIZONTAL 3-STAGE SPRAY ABSORBER (2 IN USE, 1 STAND-BY). IT IS HOPED THAT THE VENTURI DESIGN WILL ALLEVIATE THE FOULING PROBLEM. ANOTHER DESIGN FEATURE OF THE DUCON SYSTEM IS SEPARATE RECYCLE TANKS FOR VENTURI AND ABSORBER. FRESH SCRUBBING LIQUOR IS INTRODUCED AT THE ABSORBER, ENTERS THE ABSORBER RECYCLE TANK AND PARTIALLY OVERFLOWS TO THE VENTURI WHERE IT IS RECYCLED AND FINALLY DISPOSED OF IN ON-SITE WASTE WELLS. IN A COMPLETE CYCLE, THE SCRUBBER LIQUOR IS RECYCLED 4 TIMES BEFORE DISPOSAL.

A VOLUME OF 78,000 ACFM @ 600 F WILL BE HANDLED BY EACH SCRUBBER. FURTHERMORE, EACH TRAIN CAN TREAT 50% OF THE LOAD AND CAN BE ISOLATED FROM THE FLUE GAS FLOW. IT IS HOPED THAT THIS SYSTEM DESIGN WILL YIELD SIGNIFICANTLY HIGHER AVAILABILITIES THAN THE DESIGN CURRENTLY IN USE.

THE DUCON ABSORBER MODULE IS CONSTRUCTED OF FIBERGLASS. THE VENTURI IS MADE OF 316L SS. THE OVERALL DIMENSIONS OF THE SYSTEM ARE 12 FEET X 23 FEET X 25 FEET. THE SPRAY NOZZLES WILL BE NYLON

TEXACO INCORPORATED; SAN ARDO, CALIFORNIA (CONTINUED)

OR STAINLESS STEEL. BOTH THE ABSORBER AND VENTURI RECYCLE PUMPS ARE MANUFACTURED BY GALLIGER. THEY ARE RUBBER-LINED AND SIZED 800 AND 1200 GPM RESPECTIVELY AT 40 HP. THERE ARE 2 GARDEN CITY FANS PER UNIT RATED AT 100 HP EACH. DUCON HAS GUARANTEED 95% SO2 REMOVAL EFFICIENCY.

REFER TO FIGURE 14-43 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

OPERATING HISTORY

3RD QUARTER-1978 TEXACO HAS TAKEN DELIVERY ON ONE DUCON SYSTEM. DELIVERY ON THE OTHER UNITS IS EXPECTED SOON. THE UNITS ARE SCHEDULED TO START-UP WITH A NAOH SYSTEM. CONSIDERATION IS BEING GIVEN TO FUTURE CONVERSION TO NA2CO3.

4TH QUARTER-1978 CONSTRUCTION IS PROGRESSING AS SCHEDULED AND THE SYSTEMS WILL BE SODIUM CARBONATE SCRUBBING. THE THREE FGD SYSTEMS ARE ON THE PLANT SITE. THE SYSTEMS ARE SCHEDULED TO BE ONSTREAM IN MARCH 1979.

SECTION 11

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	C.A.M.(CARBIDE-AMOCO-MONSANTO)
INSTALLATION LOCATION	HOUSTON, TEXAS
SOURCE CHARACTERISTICS	FUEL NOT YET SELECTED
SOURCE RATING	1,200,000 SCFM (1 BOILER)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	600 MW (EQUIVALENT); 1 BOILER
	(FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	VENDOR NOT YET SELECTED
CONTROL PROCESS	PROCESS NOT YET SELECTED
NEW / RETROFIT	NEW
START-UP DATE	1984
CONTROL SYSTEM STATUS	PLANNED-CONSIDERING SO2 CONTROL
SO2 REMOVAL EFFICIENCY	NOT DETERMINED
SLUDGE OR BY-PRODUCT DISPOSAL	DISPOSAL TECHNIQUE NOT KNOWN

BACKGROUND INFORMATION

UNION CARBIDE, AMOCO AND MONSANTO HAVE ENTERED IN A JOINT VENTURE (C.A.M.) TO ERECT A COGENERATION FACILITY NEAR HOUSTON, TEXAS. THE CAM PLANT WILL BE DESIGNED TO PROVIDE 3 MILLION LBS/HOUR STEAM FOR PROCESS USE BY THE TEXAS CITY PLANTS OF THE THREE COMPANIES. AS A COGENERATION PLANT, CAM WILL ALSO PROVIDE STEAM FOR COMMUNITY PUBLIC SERVICE COMPANY TO GENERATE ABOUT 100-MW OF ELECTRICITY FOR THE AREA. CAM WILL ALSO SAVE ENERGY BY OPERATING AT A 75% FUEL EFFICIENCY COMPARED TO THE 35% FOR THE CONVENTIONAL ELECTRIC UTILITY PLANTS.

THE TYPE OF COAL OR LIGNITE TO BE USED IS NOT FINALIZED. HOWEVER, IT IS CERTAIN THAT AN FGD SYSTEM WILL BE REQUIRED. STARTUP FOR THE FACILITY IS SCHEDULED FOR 1984.

OPERATING HISTORY

3RD QUARTER-1978 THE SYSTEM IS STILL IN THE VERY EARLY STAGES OF DEVELOPMENT. STEARNS-ROGERS HAS BEEN CONTRACTED TO DO PRIMARY ENGINEERING AND AID IN THE CHOICE OF AN FGD SYSTEM AND VENDOR. AS OF THIS REPORT PERIOD, COAL TYPE HAS NOT BEEN CHOSEN AND A CONTROL SYSTEM OR SYSTEM VENDOR HAS NOT BEEN SELECTED.

4TH QUARTER-1978 THE SYSTEM IS NOW UNDERGOING DETAILED DESIGN ENGINEERING AND PLANNING AND IS SCHEDULED FOR FINAL REVIEW BY THE THREE COMPANIES. IF APPROVED BY ALL THREE PARTNER COMPANIES, CONSTRUCTION WILL START IN EARLY 1980 WITH COMPLETION OF THE PROJECT SCHEDULED FOR 1984. THE SELECTION OF CONTROL SYSTEM IS EXPECTED BY THE END OF THE NEXT QUARTER.

SECTION 11 (CONTINUED)

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CARBORUNDUM ABRASIVES
INSTALLATION LOCATION	BUFFALO, NEW YORK
SOURCE CHARACTERISTICS	COAL (2.2% SULFUR)
SOURCE RATING	30,000 SCFM (TOTAL - 2 BOILERS)
	160,000 LBS/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	15 MW (EQUIVALENT)
	(FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING
CONTROL SYSTEM VENDOR	CARBORUNDUM ENVIR. SYS. LTD.
CONTROL PROCESS	LIME SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	1980
CONTROL SYSTEM STATUS	PLANNED-CONTRACT AWARDED
SO2 REMOVAL EFFICIENCY	95%
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT

BACKGROUND INFORMATION

AT THE CARBORUNDUM ABRASIVES PLANT IN BUFFALO, NEW YORK THERE ARE 4 COAL-FIRED BOILERS BURNING 2.2% SULFUR COAL WITH AN AVERAGE HEAT VALUE OF 13,000 BTU/LB. TWO OF THESE BOILERS ARE IDENTICAL AND HAVE A TOTAL STEAM GENERATING CAPACITY OF 160,000 LB/HR.

THE FLUE GASES FROM THE TWO BOILERS WILL BE CONTROLLED BY A VENTURI SCRUBBER (4 FT INLET, 13 IN THROAT, 13 FT HIGH) FOLLOWED BY A 6-STAGE SPRAY TOWER (8.5 FT DIA X 38 FT HIGH). THE FGD SYSTEM WAS DESIGNED BY CARBORUNDUM ENVIRONMENTAL SYSTEMS LTD., AND WILL HANDLE 40,000 ACFM, OR 100% OF THE FLUE GAS FROM BOTH BOILERS. LIME WILL BE USED AS THE SCRUBBING MEDIUM AND THE DESIGN SO2 REMOVAL EFFICIENCY IS 95%. THE SPRAY TOWER IS DESIGNED TO OPERATE AT 125 F WITH AN L/G RATIO OF 80 GAL/1000 ACF. THE MAXIMUM LIQUID FLOW RATE IS 3000 GPM. MAKE-UP WATER WILL BE FED TO THE TOP OF THE ABSORBER AT A RATE OF 45 GPM, WHILE A 30 GPM BLEED STREAM WILL FLOW FROM THE RECIRCULATION TANK DIRECTLY TO AN EXISTING TERTIARY WASTE TREATMENT FACILITY.

REFER TO FIGURE 14-6 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

PARTICULATE REMOVAL OPERATING HISTORY

THE VENTURI AND ABSORBER MODULE WERE INSTALLED IN 1975. THE VENTURI WAS PUT INTO SERVICE FOR PARTICULATE REMOVAL AT THAT TIME USING WATER AS THE SCRUBBING MEDIUM. THE HIGH CHLORIDE CONTENT OF THE FLUE GAS HAS CAUSED SERIOUS CORROSION PROBLEMS. EFFLUENT FROM THE VENTURI HAS A PH OF 2.8. THE 316L SS VENTURI WILL BE REPLACED WITH A HASTELLOY-C UNIT BEFORE START-UP FOR SO2 REMOVAL. THE ABSORBER, ALSO OF 316L SS IS BEING USED AS A SEPARATOR AND IS ALSO BADLY CORRODED. AN FRP UNIT WILL

CARBORUNDUM ABRASIVES: BUFFALO, NEW YORK (CONTINUED)

BE INSTALLED TO REPLACE IT AND WILL INCLUDE A 3-PASS CHEVRON MIST ELIMINATOR, ALSO MADE OF FRP. AN ACID-RESISTANT COATING WAS RECENTLY APPLIED TO THE STACK LINER. COMPLETION OF THESE MODIFICATIONS, AND START-UP FOR SO2 REMOVAL ARE SCHEDULED FOR 1980.

SECTION 11 (CONTINUED)

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CATERPILLAR TRACTOR CO.
INSTALLATION LOCATION	MAPLETON, ILLINOIS
SOURCE CHARACTERISTICS	COAL (3.2% SULFUR)
SOURCE RATING	105,000 SCFM (TOTAL - 2 BOILERS) 80,000 ACFM @ 350 F, FOR EACH OF 2 FGD SYSTEMS. 500,000 LB/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	52 MW (EQUIVALENT); TOTAL - 2 BOILERS. (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	DOUBLE ALKALI (CONCENTRATED)
NEW / RETROFIT	NEW
START-UP DATE	JANUARY, 1980 2 SYSTEMS WILL START UP IN 1979-1979 HEATING SEASON.
CONTROL SYSTEM STATUS	PLANNED-CONTRACT AWARDED
SO2 REMOVAL EFFICIENCY	90% (2000 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL 60+% SOLIDS (CASO4) SLUDGE DIRECTLY TO LANDFILL.

BACKGROUND INFORMATION

AT THE MAPLETON, ILLINOIS PLANT, CATERPILLAR TRACTOR IS INSTALLING TWO NEW BOILERS WHICH WILL BE COMPLETED BY THE EARLY 1980'S. EACH BOILER IS RATED AT 250,000 LB/HR STEAM AND WILL HAVE A SEPARATE FGD SYSTEM. CATERPILLAR HAS AWARDED THE CONTRACT TO FMC ENVIORNMENTAL EQUIPMENT TO PROVIDE CONCENTRATED DUAL ALKALI FGD SYSTEMS FOR THESE TWO BOILERS. THE SCRUBBERS WILL SHARE SCRUBBING LIQUOR REGENERATION AND SLUDGE HANDLING FACILITIES. FOR MORE INFORMATION, REFER TO THE CATERPILLAR MAPLELTON ENTRY IN SECTION 10 OF THIS REPORT.

SECTION 11 (CONTINUED)

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	CHEVRON U.S.A. INC.
INSTALLATION LOCATION	BAKERSFIELD, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.1% SULFUR)
SOURCE RATING	146,000 SCFM (TOTAL - 12 BOILERS)
	150,000 ACFM @ 500 F, FOR EACH OF 2 FGD SYSTEMS
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	12
SOURCE CAPACITY	73 MW (EQUIVALENT); TOTAL - 12 BOILERS
	600 MM BTU/HR (TOTAL - 12 BOILERS; 6 BOILERS/FGD SYSTEM)
	(FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	KOCH ENGINEERING
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	APRIL, 1979
CONTROL SYSTEM STATUS	PLANNED-REQUESTING/EVALUATING BIDS
SO2 REMOVAL EFFICIENCY	90% (680 PPM @ INLET)
WATER MAKE-UP	12 - 13 GPM
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT

BACKGROUND INFORMATION

CHEVRON U.S.A. HAS AN OIL SITE AT BAKERSFIELD, CALIFORNIA. THERE ARE ABOUT 50 STEAM GENERATORS WHICH BURN 1.1% CRUDE OIL. EACH GENERATOR IS RATED AT 50 MM BTU/HR. THE STEAM IS USED FOR ENHANCED OIL RECOVERY FROM THE OIL WELLS.

A CONTRACT WAS AWARDED TO KOCH ENGINEERING TO CONSTUCT TWO MORE FGD SYSTEMS. THE DESIGN WILL BE SIMILAR TO EXISTING NA2CO3 SCRUBBING UNITS. REFER TO SECTION 9 OF THIS REPORT FOR DETAILS ON THESE FGD SYSTEMS.

OPERATING HISTORY

4TH QUARTER-1978. THE FGD SYSTEMS ARE UNDER DESIGN. THE CONSTRUCTION WILL START IN JANUARY 1979. THE START-UP IS STILL EXPECTED TO BE APRIL, 1979.

SECTION 11 (CONTINUED)

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	DUPONT, INC.
INSTALLATION LOCATION	GEORGIA
SOURCE CHARACTERISTICS	COAL (1.5% SULFUR)
SOURCE RATING	280,000 SCFM (TOTAL - 3 BOILERS) 1,200,000 LB/HR STEAM (TOTAL - 3 BOILERS)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	3
SOURCE CAPACITY	140 MW (EQUIVALENT) (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	VENDOR NOT YET SELECTED
CONTROL PROCESS	DOUBLE ALKALI
NEW / RETROFIT	NEW
START-UP DATE	1987
CONTROL SYSTEM STATUS	PLANNED-CONSIDERING SO2 CONTROL
SO2 REMOVAL EFFICIENCY	90%
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL

SECTION 11 (CONTINUED)

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	DUPONT, INC.
INSTALLATION LOCATION	TEXAS
SOURCE CHARACTERISTICS	COAL (0.5% SULFUR)
SOURCE RATING	320,000 SCFM (TOTAL - 2 BOILERS)
	1,600,000 LB/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	160 MW (EQUIVALENT): TOTAL - 2 BOILERS
	(FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	VENDOR NOT YET SELECTED
CONTROL PROCESS	LIMESTONE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	1982
CONTROL SYSTEM STATUS	PLANNED-CONSIDERING SO2 CONTROL
SO2 REMOVAL EFFICIENCY	90%
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL

SECTION 11 (CONTINUED)

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	GRISSOM AIR FORCE BASE
INSTALLATION LOCATION	BUNKER HILL, INDIANA
SOURCE CHARACTERISTICS	COAL (0.9% - 4.6% SULFUR)
SOURCE RATING	32,000 SCFM (TOTAL - 3 BOILERS)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	3
SOURCE CAPACITY	16 MW (EQUIVALENT); TOTAL - 3 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	AIRPOL INDUSTRIES
CONTROL PROCESS	DOUBLE ALKALI (CONCENTRATED)
NEW / RETROFIT	1 NEW 2 RETRO
START-UP DATE	SEPTEMBER, 1979
CONTROL SYSTEM STATUS	PLANNED-CONTRACT AWARDED
SO2 REMOVAL EFFICIENCY	
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL
CONTROL SYSTEM COST	CAPITAL: $1,800,000 - $2,000,000 (1978). THIS IS THE PROJECTED TOTAL INSTALLED COST.

BACKGROUND INFORMATION

AT GRISSOM AIR FORCE BASE NEAR BUNKER HILL, INDIANA, THE AIR FORCE HAS INITIATED A PROJECT WHICH INCLUDES THE ERECTION OF A NEW 65,000 LB/HR COAL-FIRED BOILER AND AN FGD SYSTEM FOR THE NEW UNIT AND TWO EXISTING 40,000 LB/HR COAL-FIRED UNITS. THE NAVY IS THE MILITARY CONSTRUCTION AGENT FOR THE PROJECT AND ARNOLD M. DIAMOND HAS THE OVERALL CONSTRUCTION CONTRACT. COAL FOR THE BOILERS MAY RANGE FROM 0.9% - 4.6% SULFUR AND WILL HAVE AN AVERAGE HEATING VALUE OF 11,500 BTU/LB. THE BOILERS FIRE APPROXIMATELY WITH 40% EXCESS AIR.

AIR POLLUTION INDUSTRIES, INC. (AIRPOL) HAS BEEN AWARDED A CONTRACT TO SUPPLY A CONCENTRATED DOUBLE ALKALI FGD SYSTEM. THE SYSTEM WILL HAVE A GUARANTEED MAXIMUM SO2 OUTLET CONCENTRATION OF 1.2 LB/MILLION BTU AND A MAXIMUM PARTICULATE CONCENTRATION OF 0.171 LB/MILLION BTU. FLUE GAS FROM EACH BOILER WILL PASS THROUGH A MECHANICAL COLLECTOR. THE GAS FROM ALL THREE BOILERS WILL THEN BE MANIFOLDED TOGETHER AND PASS THROUGH TWO PARALLEL ABSORBER TRAINS, EACH CAPABLE OF HANDLING 50% OF THE FLUE GAS. THE MAXIMUM FLOW RATE IS 80,473 ACFM @ 463 F.

THE AIRPOL SYSTEM CONSISTS OF 2 PARALLEL 316 SS VENTURI SCRUBBERS, EACH FOLLOWED BY A CYCLONIC SEPARATOR AND STUB STACK. THERE IS A COMMON RECIRCULATION TANK MADE OF 316 STAINLESS STEEL AND TWO 600 GPM RUBBER-LINED RECIRCULATION PUMPS. THE L/G RATIO IS 15 GALLONS/1000 ACF, WITH A SLURRY INLET TEMPERATURE OF 135 F AND A PH OF BETWEEN 5 AND 7. RECIRCULATION PIPES WILL BE MADE OF FRP.

A 100-200 GPM BLEED STREAM FROM THE RECIRCULATION TANK GOES TO A 316 SS LIME REACTION TANK

GRISSOM AIR FORCE BASE; BUNKER HILL, INDIANA (CONTINUED)

WHERE THE SODIUM SULFITE/SULFATE IS REACTED WITH SLAKED LIME PRODUCING CALCIUM SULFATE AND REGENERATING THE SODIUM HYDROXIDE. FROM THE REACTION TANK THE MIXED SLURRY FLOWS TO A THICKENER/ CLARIFIER, WHERE INSOLUBLE CALCIUM COMPOUNDS ARE SEPARATED FROM THE CLEAR OVERFLOW CONTAINING THE REGENERATED NAOH. THE CLARIFIER OVERFLOW IS RETURNED TO THE ABSORBER, WHILE THE UNDERFLOW IS REACTED ONCE AGAIN WITH LIME IN A PIPELINE MIXER TO PRECIPITATE ANY RESIDUAL SULFITE AS SULFATE. THE SLURRY IS THEN FILTERED IN A ROTARY FILTER, AND THE FILTRATE IS RETURNED TO THE REACTION TANK. THE FILTER CAKE WILL BE LANDFILLED. THE TANKS WILL BE MADE OF 316 SS AND THE PIPING OF FRP. THE LIME STORAGE TANK AND SLAKER WILL BE CARBON STEEL.

SECTION 11 (CONTINUED)

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	SHELL OIL COMPANY
INSTALLATION LOCATION	BAKERSFIELD, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.1% SULFUR)
SOURCE RATING	99,000 SCFM (TOTAL - 8 BOILERS) 400 MM BTU/HR, (50 MM BTU PER BOILER)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	8
SOURCE CAPACITY	50 MW (EQUIVALENT) (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	VENDOR NOT YET SELECTED
CONTROL PROCESS	PROCESS NOT YET SELECTED
NEW / RETROFIT	NEW
START-UP DATE	
CONTROL SYSTEM STATUS	PLANNED-CONSIDERING SO2 CONTROL
SO2 REMOVAL EFFICIENCY	94% (575 PPM SO2 @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	DISPOSAL TECHNIQUE NOT KNOWN

BACKGROUND INFORMATION

SHELL OIL IS CONSIDERING IMPLEMENTING FGD TECHNOLOGY TO CONTROL EMISSIONS FROM 8 SMALL OIL-FIRED (1.1% SULFUR) STEAM GENERATORS. NO PROCESS OR START-UP DATE HAVE AS YET BEEN SPECIFIED. AN SO2 REMOVAL EFFICIENCY OF 94% WILL BE REQUIRED.

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	SHELL OIL COMPANY
INSTALLATION LOCATION	TAFT, CALIFORNIA
SOURCE CHARACTERISTICS	OIL (1.1% SULFUR)
SOURCE RATING	25,000 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	0
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	12 MW (EQUIVALENT); 100 MM BTU/HR; TOTAL - 2 BOILERS
	(FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	VENDOR NOT YET SELECTED
CONTROL PROCESS	PROCESS NOT YET SELECTED
NEW / RETROFIT	NEW
START-UP DATE	
CONTROL SYSTEM STATUS	PLANNED-CONSIDERING SO2 CONTROL
SO2 REMOVAL EFFICIENCY	94% (575 PPM SO2 @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	DISPOSAL TECHNIQUE NOT KNOWN

BACKGROUND INFORMATION

SHELL OIL IS CONSIDERING IMPLEMENTING FGD TECHNOLOGY TO CONTROL EMISSIONS FROM 2 SMALL OIL-FIRED (1.1% SULFUR) STEAM GENERATORS. NO PROCESS OR START-UP DATE HAVE AS YET BEEN SPECIFIED. AN SO2 REMOVAL EFFICIENCY OF 94% WILL BE REQUIRED.

SECTION 11 (CONTINUED)

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	TENNECO OIL CO.
INSTALLATION LOCATION	GREEN RIVER, WYOMING
SOURCE CHARACTERISTICS	COAL (1.5% SULFUR, MAXIMUM)
SOURCE RATING	140,000 SCFM (TOTAL - 2 BOILERS) 2 FGD SYSTEMS, EACH TREATING 120,000 ACFM @ 450 F.
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	70 MW (EQUIVALENT); 640 MM BTU/HR (TOTAL - 2 BOILERS). (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	VENDOR NOT YET SELECTED
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	JANUARY, 1982
CONTROL SYSTEM STATUS	PLANNED-REQUESTING/EVALUATING BIDS
SO2 REMOVAL EFFICIENCY	90% (0.2 LB/MM BTU @ OUTLET)
SLUDGE OR BY-PRODUCT DISPOSAL	HOLDING POND FOR EVAPORATION

BACKGROUND INFORMATION

TENNECO OIL COMPANY HAS ANNOUNCED PLANS FOR A SODA ASH PLANT IN GREEN RIVER, WYOMING. THE DESIGN AND CONSTRUCTION COMPANY WILL BE BROWN AND ROOT, INC. THE PLANT WILL HAVE TWO 300,000 LB/HR BOILERS, WHICH WILL BURN LOW-SULFUR WYOMING COAL (1.5 SULFUR, MAX., 10,000 BTU/LB, 14% MOISTURE, 6% ASH).

THE FLUE GASES FROM EACH BOILER (120,000 ACFM @ 450 F) WILL BE TREATED BY AN FGD SYSTEM USING SODIUM CARBONATE SCRUBBING. THE SYSTEMS WILL BE UILT NEW AND GO ONSTREAM IN EARLY-1982 AT THE SAME TIME AS THE SODA ASH PLANT.

SECTION 11 (CONTINUED)

DESIGN INFORMATION FOR PLANNED FGD SYSTEMS ON INDUSTRIAL BOILERS

INSTALLATION NAME	WESTERN CORRECTIONAL INST.
INSTALLATION LOCATION	PITTSBURG, PENNSYLVANIA
SOURCE CHARACTERISTICS	COAL (3.5% SULFUR)
SOURCE RATING	10,000 SCFM (TOTAL - 1 BOILER) 20,000 ACFM @ 600F
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	30,000 LB/HR STEAM 5 MW (EQUIVALENT), 38 MM BTU/HR (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	PITTSBURG ENV. & ENGY. SYSTEMS
CONTROL PROCESS	SULF-X SCORE
NEW / RETROFIT	RETROFIT
START-UP DATE	NOVEMBER, 1979
CONTROL SYSTEM STATUS	PLANNED-CONTRACT AWARDED
SO2 REMOVAL EFFICIENCY	90% (2000 PPM @ INLET) 60% NOX REMOVAL (200 PPM @ INLET)

BACKGROUND INFORMATION

THE WESTERN CORRECTIONAL INSTITUTION IN PITTSBURGH, PA. HAS TWO IDENTICAL COAL-FIRED BOILERS, EACH RATED AT 30,000 LB/HR STEAM. ONE BOILER IS ALWAYS ON STAND-BY AND THE OPERATING BOILER BURNS HIGH SULFUR (3.5% S) PENNSYLVANIA BITUMINOUS COAL.

THE FGD SYSTEM, SULF-X SCORE PROCESS, WILL BE RETROFITTED BY PITTSBURGH ENVIRONMENTAL AND ENERGY SYSTEMS, INC. THE PROCESS HAS DEMONSTRATED SO2 AND NOX REMOVAL CAPABILITIES ON A 1-MW BOILER AT THE U.S. ARMY POWER PLANT AT FORT BENJAMIN, HARRISON, PA. IRON SULFIDE (FES) SLURRY IS USED AS THE ABSORBENT WHICH REACTS WITH SO2 AND NO TO FORM IRON OXIDE (FEO), IRON BISULFIDE (FES2) AND NITROGEN. THE BLEED-OFF STREAM IS SENT THROUGH A THICKENER, VACUUM FILTER AND A CALCINER WHERE THE IRON COMPOUNDS ARE REDUCED BY COAL TO FES AND S. FES IS RECYCLED WHILE S IS RECOVERED AS A BY-PRODUCT. THE ABSORBER (5 FT. DIA. X 30 FT. HIGH) WILL HAVE 4 KOCH ENGINEERING FLEXITRAYS AND A FLEXIMESH DEMISTER. THE FLUE GAS (20,000 ACFM @ 600 F) WILL CONTAIN 2000 PPM SO2 AND 200 PPM NO WHICH WILL BE REDUCED TO 200 PPM AND 80 PPM RESPECTIVELY. THE ABSORBER WILL BE MADE OF 316L SS, BUT THE REGENERATION SECTION WILL BE PRIMARILY OF CARBON STEEL.

OPERATING HISTORY

4TH QUARTER-1978 THE SYSTEM IS IN THE DESIGN PHASE. THE ABSORBER SECTION ONLY OF THE FGD SYSTEM WILL BE STARTED UP IN MAY 1979 AND TESTED FOR A SHORT DURATION. THE REGENERATION LOOP WILL BE COMPLETED BY LATE FALL OF 1979.

SECTION 12

DESCRIPTION OF INDUSTRIAL BOILER FGD SYSTEMS NOT OPERATING

INSTALLATION NAME	BUNGE, INC.
INSTALLATION LOCATION	CAIRO, ILLINOIS
SOURCE CHARACTERISTICS	COAL (3% SULFUR)
SOURCE RATING	44,000 SCFM (TOTAL - 2 BOILERS) 81,400 ACFM @ 520 F
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	22 MW (EQUIVALENT); TOTAL - 2 BOILERS 180,000 LBS/HR STEAM (TOTAL) (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	DRAVO CORP./NAT'L LIME ASS'N
CONTROL PROCESS	LIME SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	SEPTEMBER, 1977
CONTROL SYSTEM STATUS	INDEFINITELY SHUT DOWN
SO2 REMOVAL EFFICIENCY	98% (2700 PPM INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

BUNGE PURCHASED THIS LIME SCRUBBING SYSTEM FOR TESTING PURPOSES. THE LEWIS SCRUBBER, WHICH IS A HORIZONTAL ROTARY VESSEL WITH INTERNAL CHAINS, PERFORMED VERY WELL DURING THE TEST (98 PERCENT SO2 REMOVAL). PRESENTLY, BUNGE IS USING LOW SULFUR COAL (0.9 PERCENT) AND HAS NO PLANS TO RESTART FGD OPERATIONS.

SECTION 12 (CONTINUED)

DESCRIPTION OF INDUSTRIAL BOILER FGD SYSTEMS NOT OPERATING

INSTALLATION NAME	GREAT WESTERN SUGAR
INSTALLATION LOCATION	LONGMONT, COLORADO
SOURCE CHARACTERISTICS	COAL (0.7% SULFUR)
SOURCE RATING	SCFM-N/A
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
CONTROL SYSTEM VENDOR	GREAT WESTERN SUGAR
CONTROL PROCESS	AMMONIA-LADEN PROCESS WATER
NEW / RETROFIT	RETROFIT
START-UP DATE	OCTOBER, 1973
CONTROL SYSTEM STATUS	TERMINATED
SO2 REMOVAL EFFICIENCY	35% (300-400 PPM @ INLET)
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO RIVER
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

SECTION 12 (CONTINUED)

DESCRIPTION OF INDUSTRIAL BOILER FGD SYSTEMS NOT OPERATING

INSTALLATION NAME	HARRIS MINING CO.
INSTALLATION LOCATION	SPRUCE PINE, NORTH CAROLINA
SOURCE CHARACTERISTICS	COAL (0.8% SULFUR)
SOURCE RATING	4,000 SCFM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	2 MW (EQUIVALENT); TOTAL - 2 BOILERS
	(FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	W.W. SLY MANUFACTURING CO.
CONTROL PROCESS	WATER SCRUBBING (NA,NH3 OPTN.)
NEW / RETROFIT	RETROFIT
START-UP DATE	1973
CONTROL SYSTEM STATUS	INDEFINITELY SHUT DOWN
SO2 REMOVAL EFFICIENCY	
PARTICULATE REMOVAL EFFICIENCY	96%
SLUDGE OR BY-PRODUCT DISPOSAL	DISPOSAL TECHNIQUE NOT KNOWN
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE FGD SYSTEM AT THE HARRIS MINING COMPANY LOCATED AT SPRUCE PINE, NORTH CAROLINA REMOVES FLYASH AND SULFUR DIOXIDE FROM THE FLUE GAS OF A COAL FIRED BOILER. THE SCRUBBER IS A W.W. SLY IMPINGENT TYPE SCRUBBER CONSTRUCTED OF 304 STAINLESS STEEL. THE BOILER IS RATED 1.9 MW (EQUIVALENT 200 BOILER HORSEPOWER). COAL COMPOSITION IS TYPICALLY 0.8% SULFUR AND 5% ASH. PRIMARY INTEREST IN FLUE GAS SCRUBBING IS IN FLYASH REMOVAL AND NO TESTS FOR SULFUR DIOXIDE REMOVAL EFFICIENCY HAVE BEEN MADE.

OPERATING HISTORY

2ND QUARTER-1977   NO OPERATIONAL PROBLEMS HAVE BEEN REPORTED.

1ST QUARTER-1978   THIS PLANT HAS BEEN MOVED TO THE INACTIVE SYSTEMS FILE UNTIL SUCH TIME AS ACTUAL FGD OPERATIONS BEGIN. THE SCRUBBER IS EQUIPPED WITH ALKALI ADDITION CAPABILITY, BUT WITH THE LOW SULFUR COAL CURRENTLY BEING FIRED, NO ALKALI ADDITION OR PH CONTROL IS OCCURRING.

2ND QUARTER-1978   PLANT REPORTED NO CHANGE.

3RD QUARTER-1978   PLANT REPORTED NO CHANGE.

SECTION 12 (CONTINUED)

DESCRIPTION OF INDUSTRIAL BOILER FGD SYSTEMS NOT OPERATING

INSTALLATION NAME	NORTHERN OHIO SUGAR COMPANY
INSTALLATION LOCATION	FINDLAY, OHIO
SOURCE CHARACTERISTICS	COAL (1.2% SULFUR, AVERAGE)
SOURCE RATING	65,230 SCFM (TOTAL - 2 BOILERS) 100,000 LBS/HR STEAM (TOTAL - 2 BOILERS)
NUMBER OF SEPARATE FGD UNITS	2
NUMBER OF BOILERS BEING CONTROLLED	2
SOURCE CAPACITY	33 MW (EQUIVALENT), TOTAL - 2 BOILERS (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT M THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.
CONTROL SYSTEM VENDOR	GREAT WESTERN SUGAR
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	OCTOBER, 1974
CONTROL SYSTEM STATUS	TERMINATED
SO2 REMOVAL EFFICIENCY	76% (600 PPM @ INLET)
PARTICULATE REMOVAL EFFICIENCY	90%
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO CITY SEWER BLEED-OFF STREAM TO HOLDING TANK
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE NORTHERN OHIO SUGAR COMPANY HAS TERMINATED ALL SUGAR PRODUCTION OPERATIONS AT FINDLAY OHIO. THE PLANT IS NOW OPEN ONLY AS A SHIPPING AND RECEIVING STATION. THE SCRUBBER OPERATED DURING THE 1975, 1976, AND 1977 SUGAR PRODUCTION SEASONS BEFORE THE SHUTDOWN OCCURRED.

SECTION 12 (CONTINUED)

DESCRIPTION OF INDUSTRIAL BOILER FGD SYSTEMS NOT OPERATING

INSTALLATION NAME	SHELLER GLOBE CORP.
INSTALLATION LOCATION	NORFOLK, VIRGINIA
SOURCE CHARACTERISTICS	COAL (< 1.0% SULFUR)
SOURCE RATING	8,000 SCFM (TOTAL - 1 BOILER)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	4 MW (EQUIVALENT): TOTAL - 1 BOILER (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	W.W. SLY MANUFACTURING CO.
CONTROL PROCESS	SODIUM HYDROXIDE SCRUBBING
NEW / RETROFIT	RETROFIT
START-UP DATE	1975
CONTROL SYSTEM STATUS	INDEFINITELY SHUT DOWN
SO2 REMOVAL EFFICIENCY	NOT DETERMINED
PARTICULATE REMOVAL EFFICIENCY	NOT DETERMINED
SLUDGE OR BY-PRODUCT DISPOSAL	OVERFLOW TO SEWER/SLUDGE TO LANDFILL
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

IN NORFOLK, VIRGINIA, SHELLER GLOBE CORPORATION OPERATES THE MITCHELL SMITH DIVISION PLANT, WHERE THE PRIMARY PRODUCT IS CORK RUBBER GASKET MATERIAL. PROCESS (AUTOCLAVE) AND HEATING STEAM ARE SUPPLIED BY A BOILER RATED AT 350 BOILER HP (ABOUT 3.5 MW EQUIVALENT). STEAM CONDITIONS ARE 125 PSI AT 325 F. THE BOILER WAS ORIGINALLY ERECTED IN 1939, BUT UNDERWENT A COMPLETE OVERHAUL IN 1977. BOILER TUBES, REFRACTORY BRICK, GRATE, AND SOOT BLOWERS WERE REPLACED DURING THE OVERHAUL. THE BOILER FIRES COAL SUPPLIED BY GENERAL COAL - NOMINAL SIZE IS 1.25 X 0.25 INCHES. COAL CHARACTERISTICS ARE AS FOLLOWS: HHV=13,200 BTU/LB, ASH=6%, AND SULFUR IS LESS THAN 1%.

THE EMISSIONS CONTROL SYSTEM AT SHELLER GLOBE CONSISTS OF A W.W. SLY SINGLE-STAGE IMPINJET SCRUBBER (#170) WHICH REMOVES PARTICULATE AND SO2 FROM THE FLUE GAS. THE SYSTEM USES A NAOH MAKE-UP PRIMARILY FOR CORROSION CONTROL BUT SO2 CONTROL IS AN ADDITIONAL BENEFIT. RECYCLE TANK SUPERNATANT IS PH NEUTRALIZED AND IS DISCHARGED TO CITY SEWERS WHILE FLY ASH AND SEDIMENT ARE SETTLED, SCRAPED OUT AND HAULED TO A SANITARY LANDFILL.

THE SCRUBBER MODULE IS CONSTRUCTED OF 316L SS (10 FT DIA X 15 FT HIGH). THE FLUE GAS RATE ENTERING THE SCRUBBER IS 19,200 CFM @ 450 F. THE DUCTING ENTERING AND EXITING THE SCRUBBER IS MADE OF 3/8" C.S. AND CORTEN STEEL RESPECTIVELY. THE W.W. SLY FAN (BOILER ID) IS MADE OF CARBON STEEL. THE RECYCLE TANK IS CONSTRUCTED OF UNLINED STEEL (20 FT X 10 FT X 8 FT) AND THE PIPING IS OF PVC. CHEMICALS ARE PURCHASED FROM THE CHEMICAL TREATMENT CO. WHO ALSO OPERATE THE SCRUBBING SYSTEM.

REFER TO FIGURE 14-90 IN SECTION 14 FOR A DETAILED PROCESS FLOW DIAGRAM OF THIS SYSTEM.

SECTION 12 (CONTINUED)

DESCRIPTION OF INDUSTRIAL BOILER FGD SYSTEMS NOT OPERATING

SHELLER GLOBE CORP.; NORFOLK, VIRGINIA (CONTINUED)

OPERATING HISTORY

UPON INITIAL STARTUP NO CAUSTIC WAS INTRODUCED TO THE SYSTEM AND WITHIN A FEW MONTHS THE INTERNALS OF THE MODULE AND THE STEEL PIPING SYSTEM WERE CORRODED BEYOND USE. THIS NECESSITATED REPLACEMENT OF THE INTERNALS, SUBSTITUTION OF STEEL PIPE WITH PVC, AND ADDITION OF NAOH TO THE SCRUBBING LIQUOR.

2ND QUARTER-1978   DURING THE REPORT PERIOD THE UNIT UNDERWENT A VIRGINIA EPA CERTIFICATION INSPECTION, AND WAS FOUND TO BE IN COMPLIANCE. NO SCRUBBER-RELATED PROBLEMS HAVE OCCURRED.

3RD QUARTER-1978   BOILER OPERATION WAS ESTIMATED TO BE AT 60% CAPACITY 24 HRS PER DAY, 6 DAYS PER WEEK. NO SCRUBBER-RELATED PROBLEMS HAVE BEEN REPORTED. PLANT PERSONNEL ARE CONSIDERING REPLACEMENT OF THE PRESENT SYSTEM DUE TO WEAR ON THE EQUIPMENT.

4TH QUARTER-1978   NO SCRUBBER RELATED PROBLEMS WERE REPORTED DURING THIS PERIOD. AT PRESENT, THE USE OF FRESH NAOH HAS BEEN DISCONTINUED.

SECTION 12 (CONTINUED)

DESCRIPTION OF INDUSTRIAL BOILER FGD SYSTEMS NOT OPERATING

INSTALLATION NAME	TRANSCO TEXTILES, INC.
INSTALLATION LOCATION	AUGUSTA, GEORGIA
SOURCE CHARACTERISTICS	FUEL OIL (2% MAX. SULFUR)
SOURCE RATING	50,000 ACFM
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	1
SOURCE CAPACITY	20 MW (EQUIVALENT) (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	FMC ENVIRONMENTAL EQUIPMENT
CONTROL PROCESS	SODIUM CARBONATE SCRUBBING
NEW / RETROFIT	NEW
START-UP DATE	MARCH, 1975
CONTROL SYSTEM STATUS	INDEFINITTELY SHUT DOWN
SO2 REMOVAL EFFICIENCY	80%-85% (610 LB/HR @ INLET)
WATER MAKE-UP	48 GPM; OPEN LOOP
SLUDGE OR BY-PRODUCT DISPOSAL	WASTEWATER TREATMENT AND DISCHARGE TO RIVER NA2SO3/SO4 LIQUOR DISCHARGED TO A HOLDING POND
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

THE FGD OPERATIONS HAVE BEEN TERMINATED FOR AN INDEFINITE PERIOD. THE PLANT BURNS NUMBER 6 FUEL OIL AND THE SULFUR DIOXIDE EMISSIONS ARE 50% OF THE EXISITING REGULATIONS. THE BOILER IS RATED AT 20 MW (EQUIVALENT) AND PRODUCES 150,000 LBS/HR STEAM. WHEN OPERATIONAL, THE SCRUBBER SYSTEM HAD A FLUE GAS VOLUME OF 50,000 ACFM AT 140 DEGREES F. SYSTEM START-UP OCCURRED IN MARCH 1975 AND SCRUBBER OPERATIONS WERE TERMINATED LATER IN THE SAME YEAR. THERE ARE CURRENTLY NO PLANS TO INITIATE OPERATIONS.

SECTION 12 (CONTINUED)

DESCRIPTION OF INDUSTRIAL BOILER FGD SYSTEMS NOT OPERATING

INSTALLATION NAME	U.S. GYPSUM CORP.
INSTALLATION LOCATION	OAKMONT, PENNSYLVANIA
SOURCE CHARACTERISTICS	COAL
SOURCE RATING	19,300 SCFM (TOTAL - 4 BOILERS)
NUMBER OF SEPARATE FGD UNITS	1
NUMBER OF BOILERS BEING CONTROLLED	4
SOURCE CAPACITY	10 MW (EQUIVALENT) (FOR THIS REPORT, UNLESS STATED OTHERWISE, 2000 SCFM = 1 EQUIVALENT MW. THIS IS BECAUSE GAS FLOW RATE IS THE PRIMARY FACTOR IN MODULE SIZING.)
CONTROL SYSTEM VENDOR	AIRPOL INDUSTRIES
CONTROL PROCESS	DOUBLE ALKALI (DILUTE)
NEW / RETROFIT	NEW
START-UP DATE	
CONTROL SYSTEM STATUS	NEVER STARTED-UP
SO2 REMOVAL EFFICIENCY	SUFFICIENT TO MEET REGULATION
PARTICULATE REMOVAL EFFICIENCY	MEETS CODE
WATER MAKE-UP	10 GPM (CLOSED LOOP)
SLUDGE OR BY-PRODUCT DISPOSAL	DEWATERED SLURRY TO LANDFILL SLUDGE TO POND FOR DRYING. THEN TO LANDFILL.
CONTROL SYSTEM COST	SEE SECTION 13 FOR DETAILED ECONOMIC INFORMATION

BACKGROUND INFORMATION

AN AIRPOL DOUBLE ALKALI SCRUBBING SYSTEM IS ON-SITE, INSTALLED, AND READY FOR OPERATIONS. HOWEVER, US GYPSUM DECIDED NOT TO INITIATE PRODUCTION AT THIS FACILITY FOR ECONOMIC REASONS. A CHECK DURING THE 4TH QUARTER 1978 REPORT PERIOD REVEALED THAT THERE ARE STILL NO PLANS TO USE THIS FACILITY.

SECTION 15

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
ALYESKA PIPELINE SERVICE CO. VALDEZ, ALASKA 50,000	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 6/77		
	PLANT PERSONNEL HAVE NOT SEPARATED OUT FGD SYSTEM COSTS FROM OVERALL PROJECT COSTS NOR DO THEY KEEP OPERATING COSTS FOR THE FGD SYSTEM.		
AMERICAN THREAD CO. MARION, NORTH CAROLINA 18,500	CAUSTIC WASTE STREAM OPERATIONAL 1973	$138,000.	$16,300.
	THE CAPITAL COST REPRESENTS TOTAL INSTALLED COST IN 1972 DOLLARS. THE OPERATING COST INCLUDES NEW FIBERGLASS LININGS IN DUCTWORK AND ON FANS AND OPERATING LABOR AND MATERIALS FOR 1977.		
ARCO/POLYMERS, INC. MONACA, PENNSYLVANIA 236,000	DOUBLE ALKALI (CONCENTRATED) CONSTRUCTION 6/80	$8,000,000.	$24,000,000.
	THE CAPITAL COST REPRESENTS THE TOTAL INSTALLED COST INCLUDING EQUIPMENT, INSTALLATION, DUCTWORK, STACK, PIPING, ENGINEERING, START-UP, TESTING, INSTRUMENTATION, ENGINEERING, AND OVERHEADS IN 1978 DOLLARS. THE PROJECTED OPERATING COST IS $8/TON OF COAL.		
ARMCO STEEL MIDDLETOWN, OHIO 84,000	LIME SCRUBBING OPERATIONAL 1975	$74,000.	
	THIS IS THE REPORTED CAPITAL COST IN 1975 DOLLARS.		
BELRIDGE OIL CO. MCKITTRICK, CALIFORNIA 12,000	SODIUM HYDROXIDE SCRUBBING CONSTRUCTION 1/79	$125,000.	
	THIS IS THE REPORTED CAPITAL COST IN 1978 DOLLARS.		

SECTION 13 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

<table>
<tr><th rowspan="2">COMPANY
LOCATION
CAPACITY (SCFM)</th><th rowspan="2">PROCESS
STATUS
START-UP DATE</th><th colspan="2">COST</th></tr>
<tr><th>CAPITAL</th><th>OPERATING</th></tr>
<tr><td>BELRIDGE OIL CO.
MCKITTRICK, CALIFORNIA
12,000</td><td>SODIUM HYDROXIDE SCRUBBING
OPERATIONAL
6/78</td><td>$100,000.</td><td></td></tr>
<tr><td></td><td colspan="3">THE CAPITAL COST INCLUDES THE SCRUBBER, RECYCLE TANK, STACK, DEMISTER, PIPING, DUCTWORK, AND INSTRUMENTATION IN 1978 DOLLARS.</td></tr>
<tr><td>BELRIDGE OIL CO.
MCKITTRICK, CALIFORNIA
12,000</td><td>SODIUM HYDROXIDE SCRUBBING
OPERATIONAL
7/78</td><td>$100,000.</td><td></td></tr>
<tr><td></td><td colspan="3">THIS IS THE REPORTED CAPITAL COST IN 1978 DOLLARS.</td></tr>
<tr><td>BUNGE, INC.
CAIRO, ILLINOIS
44,000</td><td>LIME SCRUBBING
INDEFINITELY SHUT DOWN
9/77</td><td>$1,000,000.</td><td></td></tr>
<tr><td></td><td colspan="3">THE CAPITAL COST REPRESENTS THE TOTAL INSTALLED COST OF THE FGD SYSTEM, ENGINEERING, START-UP, AND TESTING IN 1977 DOLLARS.</td></tr>
<tr><td>CANTON TEXTILES
CANTON, GEORGIA
25,000</td><td>CAUSTIC WASTE STREAM
OPERATIONAL
6/74</td><td>$138,000.</td><td>$34,000.</td></tr>
<tr><td></td><td colspan="3">THE CAPITAL COST REPRESENTS THE TOTAL COST FOR THE INSTALLED SYSTEM, IN 1974 DOLLARS.</td></tr>
</table>

SECTION 13 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	COST OPERATING
CATERPILLAR TRACTOR CO. EAST PEORIA, ILLINOIS 210,000	DOUBLE ALKALI (CONCENTRATED) OPERATIONAL 4/78		

NO ECONOMIC INFORMATION HAS BEEN SUPPLIED FOR THE CATERPILLAR FGD SYSTEMS.

CATERPILLAR TRACTOR CO. JOLIET, ILLINOIS 67,000	DOUBLE ALKALI (DILUTE) OPERATIONAL 9/74		

NO ECONOMIC INFORMATION HAS BEEN SUPPLIED FOR THE CATERPILLAR FGD SYSTEMS.

CATERPILLAR TRACTOR CO. MAPLETON, ILLINOIS 131,000	DOUBLE ALKALI (CONCENTRATED) CONSTRUCTION 1/79		

NO ECONOMIC INFORMATION HAS BEEN SUPPLIED FOR THE CATERPILLAR FGD SYSTEMS.

CATERPILLAR TRACTOR CO. MORTON, ILLINOIS 38,000	DOUBLE ALKALI (DILUTE) OPERATIONAL 1/78		

NO ECONOMIC INFORMATION HAS BEEN SUPPLIED FOR THE CATERPILLAR FGD SYSTEMS.

CATERPILLAR TRACTOR CO. MOSSVILLE, ILLINOIS 140,000	DOUBLE ALKALI (CONCENTRATED) OPERATIONAL 10/75		

NO ECONOMIC INFORMATION HAS BEEN SUPPLIED FOR THE CATERPILLAR FGD SYSTEMS.

SECTION 13 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
CHANSLOR WESTERN OIL & DEV. CO BAKERSFIELD, CALIFORNIA 70,000	DOUBLE ALKALI (CONCENTRATED) CONSTRUCTION 5/79	$1,500,000.	
	THE CAPITAL COST INCLUDES THE SCRUBBER, LIQUOR REGENERATION EQUIPMENT, AND DUCTWORK IN 1978 DOLLARS.		
CHEVRON U.S.A. INC. BAKERSFIELD, CALIFORNIA 248,000	SODIUM CARBONATE SCRUBBING OPERATIONAL 7/78	$2,000,000.	$920,000.
	THE CAPITAL COST IS IN 1978 DOLLARS. THIS REPRESENTS THE TOTAL INSTALLED COST OF THE FGD SYSTEM INCLUDING SITE PREPERATION. THE OPERATING COST INCLUDES ELECTRICITY, SODA ASH, AND MAINTENANCE (LABOR AND MATERIALS). THIS CORRESPONDS TO A 340 DAY YEAR AND APPROXIMATELY $900/DAY PER SCRUBBER IN 1978.		
FIRESTONE TIRE AND RUBBER CO. POTTSTOWN, PENNSYLVANIA 8070	DOUBLE ALKALI (CONCENTRATED) OPERATIONAL 1/75	$163,000.	$60,000.
	THE CAPITAL COST INCLUDES EQUIPMENT, ENGINEERING AND STARTUP. THE COST DOES NOT INCLUDE LABOR AND MATERIALS FOR ELECTRICAL SYSTEM, PIPING, OR STRUCTURAL AND FOUNDATIONS ERECTION IN 1974 DOLLARS. THE OPERATING COST INCLUDES CHEMICALS, LABOR, ELECTRICITY, DISPOSAL, MATERIALS, AND LAB WORK FOR 1977.		
FMC (SODA ASH PLANT) GREEN RIVER, WYOMING 446,000	SODIUM CARBONATE SCRUBBING OPERATIONAL 5/76	$10,000,000.	
	THIS TOTAL CAPITAL COST, IN 1975 DOLLARS, INCLUDES ESP AND FGD PURCHASE AND INSTALLATION COSTS.		

SECTION 15 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	COST OPERATING
GENERAL MOTORS CORPORATION DAYTON, OHIO 36,000	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 9/74	$668,000.	
THE CAPITAL COST IS THE TOTAL INSTALLED COST FOR THE TWO FGD SYSTEMS, IN 1974 DOLLARS.			
GENERAL MOTORS CORPORATION PARMA, OHIO 128,400	DOUBLE ALKALI (DILUTE) OPERATIONAL 3/74	$3,200,000.	$644,000.
THE OPERATING COST REPRESENTS $11.70/TON COAL.			
GENERAL MOTORS CORPORATION PONTIAC, MICHIGAN 107,300	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 4/76	$600,000.	
THE CAPITAL COST REPRESENTS THE TOTAL INSTALLED COST IN 1972 DOLLARS.			
GENERAL MOTORS CORPORATION ST. LOUIS, MISSOURI 64,000	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 1972	$773,000.	$172,000.
THE CAPITAL COST IS IN 1973 DOLLARS. THE OPERATING COST INCLUDES MAINTENANCE MATERIALS, LABOR AND ELECTRICITY IN 1976.			
GENERAL MOTORS CORPORATION TONOWANDA, NEW YORK 92,000	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 6/75	$2,200,000.	
THE CAPITAL COST IS IN 1974 DOLLARS.			

SECTION 13 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
GEORGIA-PACIFIC PAPER CO. CROSSETT, ARKANSAS 220,000	CAUSTIC WASTE STREAM OPERATIONAL 7/75	$275,000.	

THE CAPITAL COST REPRESENTS THE ABSORBER COST ONLY AND IS IN 1974 DOLLARS.

GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA 72,000	SODIUM CARBONATE SCRUBBING OPERATIONAL 6/77	$400,000.	$390,000.

THE CAPITAL COST INCLUDES THE ABSORBER MODULE, SODA ASH TANK, PUMPS, AND PIPING IN 1977 DOLLARS. IT DOES NOT INCLUDE THE STACK, DUCTING, ENGINEERING, OR OVERHEADS. THE OPERATING COST IS EQUIVALENT TO $0.16/MM BTU, INCLUDES THE COST FOR SODA ASH, ELECTRICITY, AND SCRUBBER MAINTENANCE, AND REPRESENTS A 340-DAY YEAR.

GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA 495,000	SODIUM CARBONATE SCRUBBING OPERATIONAL 12/78	$2,500,000.	$2,900,000.

THE CAPITAL COST INCLUDES COST OF SCRUBBER, SODA ASH TANK, PIPING, AND PUMPS IN 1978 DOLLARS FOR 5 SCRUBBER SYSTEMS. THE OPERATING COST INCLUDES ELECTRICITY, SCRUBBER MAINTENANCE, AND SODA ASH, IS BASED ON A 340-DAY YEAR, AND REPRESENTS $0.16/MM BTU FOR 5 SCRUBBING UNITS.

GETTY OIL COMPANY BAKERSFIELD, CALIFORNIA 396,000	SODIUM CARBONATE SCRUBBING CONSTRUCTION 1/79	$2,000,000.	$2,320,000.

THE CAPITAL COST INCLUDES COST OF SCRUBBER, SODA ASH TANK, PIPING, AND PUMPS IN 1978 DOLLARS FOR 4 SCRUBBER SYSTEMS. THE OPERATING COST INCLUDES ELECRICITY, SCRUBBER MAINTENANCE, AND SODA ASH, IS BASED ON A 340-DAY YEAR, AND REPRESENTS $0.16/MM BTU FOR 4 SCRUBBING UNITS.

SECTION 15 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
GREAT SOUTHERN PAPER CO. CEDAR SPRINGS, GEORGIA 420,000	CAUSTIC WASTE STREAM OPERATIONAL 1975	$600,000.	

THE CAPITAL COST IS THE EQUIPMENT COST FOR THE TWO SCRUBBER MODULES IN 1974 DOLLARS.

GREAT WESTERN SUGAR BILLINGS, MONTANA 60,000	AMMONIA-LADEN PROCESS WATER OPERATIONAL 10/77		

NO COST INFORMATION HAS BEEN SUPPLIED FOR THE BILLINGS FGD SYSTEM.

GREAT WESTERN SUGAR FORT MORGAN, COLORADO 65,230	AMMONIA-LADEN PROCESS WATER OPERATIONAL 10/76	$707,000.	$88,200.

THE CAPITAL COST IS THE TOTAL INSTALLED COST OF THE FGD SYSTEM IN 1976 DOLLARS. THE OPERATING COST INCLUDES ELECTRICITY, STEAM, MAINTENANCE, LAABOR, AND MATERIALS.

GREAT WESTERN SUGAR GERING, NEBRASKA 110,000	AMMONIA-LADEN PROCESS WATER OPERATIONAL 10/75	$643,000.	$34,600.

THE CAPITAL COST IS THE TOTAL INSTALLED COST OF THE FGD SYSTEM IN 1975 DOLLARS. THE OPERATING COST INCLUDES ELECTRICITY, MAINTANENCE, LABOR, AND MATERIALS.

GREAT WESTERN SUGAR GREELEY, COLORADO 25,000	AMMONIA-LADEN PROCESS WATER OPERATIONAL 10/75		

NO COST INFORMATION HAS BEEN SUPPLIED FOR THE GREELEY FGD SYSTEM.

SECTION 13 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
GREAT WESTERN SUGAR LONGMONT, COLORADO SCFM-N/A	AMMONIA-LADEN PROCESS WATER TERMINATED 10/73		

NO COST INFORMATION HAS BEEN SUPPLIED FOR THE LONGMONT FGD SYSTEM.

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
GREAT WESTERN SUGAR LOVELAND, COLORADO 121,800	AMMONIA-LADEN PROCESS WATER OPERATIONAL 10/73	$431,000.	$84,400.

THE CAPITAL COST REPRESENTS THE TOTAL INSTALLED COST FOR TWO SCRUBBERS, I.D. FANS, NEW BREECHING, AND WATER SYSTEM IN 1973 DOLLARS. THE OPERATING COST INCLUDES ELECTRICITY, STEAM, MAINTANENCE, LABOR, AND MATERIALS.

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
GREAT WESTERN SUGAR SCOTTS BLUFF, NEBRASKA 65,230	AMMONIA-LADEN PROCESS WATER OPERATIONAL 10/75	$523,000.	$30,200.

THE CAPITAL COST IS THE TOTAL INSTALLED COST OF THE FGD SYSTEM IN 1975 DOLLARS. THE OPERATING COST INCLUDES ELECTRICITY, STEAM, MAINTANENCE, LABOR, AND MATERIALS.

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
HARRIS MINING CO. SPRUCE PINE, NORTH CAROLINA 4,000	WATER SCRUBBING (NA,NH3 OPTN.) INDEFINITELY SHUT DOWN 1973	$31,000.	

THE CAPITAL COST IS THE TOTAL INSTALLED COST IN 1973 DOLLARS.

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
ITT RAYONIER, INC. FERNANDINA BEACH, FLORIDA 176,000	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 1975	$500,000.	

THE CAPITAL COST IS FOR 2 SCRUBBERS, DUCTWORK, AND STACKS IN 1975 DOLLARS.

SECTION 13 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	COST OPERATING
KERR-MCGEE CHEMICAL CORP. TRONA, CALIFORNIA 490,000	SODIUM CARBONATE SCRUBBING OPERATIONAL 6/78	$6,000,000.	
	KERR-MCGEE SPENT $1.5 MM IN A PILOT PLANT FOR SEVERAL YEARS BEFORE AND DURING CONSTRUCTION OF THE NEW FACILITY. OUT OF THE $200 MM PROJECT COST, $16 MM OF THAT IS FOR POWER PLANT AND $6 MM IS FOR THE BOILER'S RELATED POLLUTION CONTROL COSTS.		
MEAD PAPERBOARD CO. STEVENSON, ALABAMA 100,000	SODIUM CARBONATE SCRUBBING OPERATIONAL 1975	$173,000.	$840,000.
	THE CAPITAL COST REPRESENTS THE ORIGINAL EQUIPMENT AND INSTALLATION COST IN 1974. SINCE THEN, EXTENSIVE MODIFICATIONS HAVE BEEN REQUIRED. ANOTHER $173,000 WAS SPENT FOR REPAIRS AND UPGRADING IN 1976. OVER THE SCRUBBER PLANT LIFE, AN ADDITIONAL $136,000 HAS BEEN SPENT, INCLUDING:$ 35,000 (RUBBER LINERS), $54,000 (STAINLESS STEEL LINERS), AND $47,000 (GENERAL REPAIRS). THE OPERATING COST INCLUDES $40,000/YR FOR OPERATING LABOR, $40,000/YR FOR MAINTENANCE LABOR, AND $760,000/YR FOR REAGENT (8526 TONS).		
MINN-DAK FARMER'S CO-OPERATIVE WAHPETON, NORTH DAKOTA 164,000	AMMONIA SCRUBBING OPERATIONAL 6/77	$300,000.	
	THE CAPITAL COST REPRESENTS THE TOTAL EQUIPMENT COST IN 1977 DOLLARS.		

SECTION 13 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

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COMPANY                        PROCESS                                      COST
LOCATION                       STATUS                            ------------------------
CAPACITY (SCFM)                START-UP DATE                      CAPITAL       OPERATING
---------------                -------------                      -------       ---------

MOBIL OIL COMPANY              SODIUM CARBONATE SCRUBBING        $500,000.
BUTTONWILLOW, CALIFORNIA       CONSTRUCTION
80,500                          2/79

                     THE CAPITAL COST INCLUDES ABSORBER MODULES, RE-
                     CYCLE TANKS, STACK, DEMISTERS, PUMPS, AND PIPING
                     IN 1978 DOLLARS.  IT DOES NOT INCLUDE CAUSTIC
                     TANK, FEED PUMPS, OR FEED PIPES.


MOBIL OIL COMPANY              SODIUM HYDROXIDE SCRUBBING      $2,900,000.    $1,290,000.
SAN ARDO, CALIFORNIA           OPERATIONAL
175,000                        1974

                     THE CAPITAL COST REPRESENTS EQUIPMENT, INSTAL-
                     LATION, PIPING, DUCTWORK, STACK, WATER TREATMENT
                     FACILITY, AND INSTRUMENTATION IN 1978 DOLLARS.
                     THE OPERATING COST INCLUDES ELECTRICITY, CAUSTIC,
                     LABOR, AND MAINTENANCE.  IT DOES NOT INCLUDE IN-
                     DIRECT (FIXED) COSTS.  THE AVERAGE OPERATING COST
                     FOR THE 22 SMALLER SYSTEMS IS $35,000/YR EACH, AND
                     FOR THE 8 LARGER SYSTEMS IS $65,000/YR EACH.


NEKOOSA PAPERS, INC.           CAUSTIC SCRUBBING                 $250,000.
ASHDOWN, ARKANSAS              OPERATIONAL
211,000                         2/76

                     THE CAPITAL COST REPRESENTS THE EQUIPMENT COST IN
                     1975 DOLLARS.


NORTHERN OHIO SUGAR COMPANY    SODIUM CARBONATE SCRUBBING        $523,000.        $30,200.
FINDLAY, OHIO                  TERMINATED
65,230                         10/74

                     THE CAPITAL COST IS THE TOTAL INSTALLED COST OF
                     THE FGD SYSTEM IN 1974 DOLLARS.  THE OPERATING
                     COST INCLUDES ELECTRICITY, MAINTENANCE, LABOR, AND
                     MATERIALS.
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SECTION 13 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
NORTHERN OHIO SUGAR COMPANY FREEMONT, OHIO 40,000	SODIUM HYDROXIDE SCRUBBING OPERATIONAL 10/75		
	NO COST INFORMATION HAS BEEN SUPPLIED FOR THE FREEMONT FGD SYSTEM.		
PHILLIP MORRIS, INC. CHESTERFIELD, VIRGINIA 39,000	SODIUM CARBONATE SCRUBBING CONSTRUCTION 6/79		
	NO COST INFORMATION IS AS YET AVAILABLE.		
RICKENBACKER AIR FORCE BASE COLUMBUS, OHIO 55,000	LIMESTONE SCRUBBING OPERATIONAL 3/76	$2,200,000.	$207,000.
	THE CAPITAL COST INCLUDES ADJACENT ELECTRICAL SUBSTATION, SLUDGE DISPOSAL, EXTERNAL FLUES, AND OTHER ATYPICAL EQUIPMENT IN 1975 DOLLARS. THE OPERATING COST REPRESENTS THE OVERALL 1977 COST FOR 35,000 TONS OF COAL. DURING THE 1977 U.S.E.P.A. DEMONSTRATION TEST, OPERATING COSTS WERE $5.61/TON OF COAL. THESE COSTS INCLUDE OPERATING AND MAINTENANCE, LABOR, POWER, WATER, MAINTENANCE PARTS, AND SLUDGE DISPOSAL, BUT DOES NOT INCLUDE DEPRECIATION.		
SHELLER GLOBE CORP. NORFOLK, VIRGINIA 8,000	SODIUM HYDROXIDE SCRUBBING INDEFINITELY SHUT DOWN 1975	$80,000.	
	THE CAPITAL COST IS THE ESTIMATED REPLACEMENT COST IN 1978. AN ESTIMATED MAINTENANCE COST OF $160/MO WAS REPORTED (2 MAN-DAYS/MO).		

SECTION 13 (CONTINUED)

INDUSTRIAL BOILER FGD COSTS

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
ST. JOE ZINC CO. MONACA, PENNSYLVANIA 142,000	CITRATE PROCESS CONSTRUCTION 3/79	$12,700,000.	

THE CAPITAL COST IS IN 1977 DOLLARS AND IS BEING JOINTLY FUNDED BY ST. JOE ZINC, THE US EPA, AND THE U.S. BUREAU OF MINES.

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
ST. REGIS PAPER CO. CANTONMENT, FLORIDA 115,000	CAUSTIC SCRUBBING OPERATIONAL 1973	$100,000.	

THE CAPITAL COST IS FOR THE ABSORBER ONLY AND IS IN 1973 DOLLARS.

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
SUN PRODUCTION COMPANY FELLOWS, CALIFORNIA 6,000	SODIUM HYDROXIDE SCRUBBING CONSTRUCTION 4/79	$100,000.	$35,000.

THE CAPITAL COST IS THE TOTAL INSTALLED COST OF THE FGD SYSTEM IN 1979 DOLLARS. THE ESTIMATED OPERATING COST INCLUDES ONLY DIRECT COSTS OF RAW MATERIALS (50 LB/HR OF 50 % CAUSTIC, 4 GPM MAKEUP WATER), AND ELECTRICITY (16 HP).

COMPANY LOCATION CAPACITY (SCFM)	PROCESS STATUS START-UP DATE	COST CAPITAL	 OPERATING
SUN PRODUCTION COMPANY OILDALE, CALIFORNIA 6,000	SODIUM HYDROXIDE SCRUBBING CONSTRUCTION 4/79	$100,000.	$35,000.

THE CAPITAL COST IS THE TOTAL INSTALLED COST OF THE FGD SYSTEM IN 1979 DOLLARS. THE ESTIMATED OPERATING COST INCLUDES ONLY DIRECT COSTS OF RAW MATERIALS (50 LB/HR OF 50% CAUSTIC, 4 GPM MAKEUP WATER), AND ELECTRICITY (16 HP).

```
COMPANY                       PROCESS                                            COST
LOCATION                      STATUS                                 --------------------------
CAPACITY (SCFM)               START-UP DATE                          CAPITAL          OPERATING
---------------               -------------                          -------          ---------

TEXACO INCORPORATED           SODIUM HYDROXIDE SCRUBBING
SAN ARDO, CALIFORNIA          OPERATIONAL
380,000                       11/73

                  NO ECONOMIC INFORMATION HAS AS YET BEEN PROVIDED
                  BY TEXACO.



TEXACO INCORPORATED           SODIUM CARBONATE SCRUBBING
SAN ARDO, CALIFORNIA          CONSTRUCTION
117,000                        3/79

                  NO ECONOMIC INFORMATION HAS AS YET BEEN PROVIDED
                  BY TEXACO.



TEXASGULF                     SODIUM CARBONATE SCRUBBING
GRANGER, WYOMING              OPERATIONAL
140,000                        9/76

                  THE CAPITAL COST IS FOR TWO SCRUBBING UNITS ONLY
                  AND IS IN 1976 DOLLARS.



TRANSCO TEXTILES, INC.        SODIUM CARBONATE SCRUBBING
AUGUSTA, GEORGIA              INDEFINITELY SHUT DOWN
50,000                         3/75

                  NO ECONOMIC INFORMATION WAS MADE AVAILABLE.



U.S. GYPSUM CORP.             DOUBLE ALKALI (DILUTE)
OAKMONT, PENNSYLVANIA         NEVER STARTED-UP
19,300

                  NO ECONOMIC INFORMATION WAS MADE AVAILABLE.
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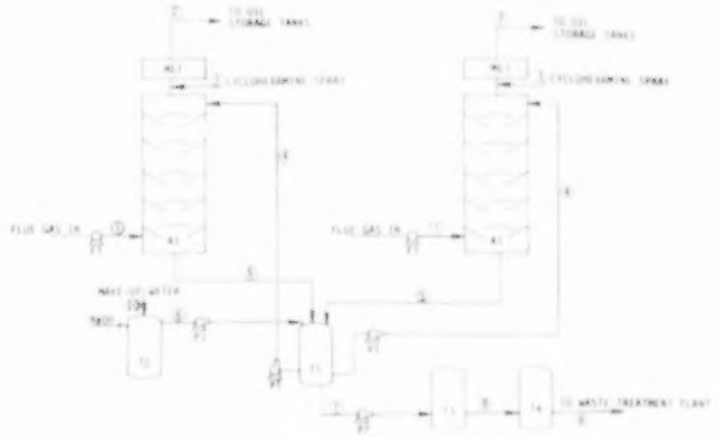

TO OIL STORAGE TANKS
TO OIL STORAGE TANKS
ME1
ME1
CYCLOHEXAMINE SPRAY
CYCLOHEXAMINE SPRAY
FLUE GAS IN
FLUE GAS IN
①
A1
A1
F1
F1
MAKE-UP WATER
NaOH
T2
P3
T1
P1
P2
T3
T4
TO WASTE TREATMENT PLANT

Figure 14-1. Alyeska Pipeline Service Co.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO
A1	ABSORBER			2
F1	I.D. FAN			2
ME1	MIST ELIMINATOR			2
P1	RECIRCULATION PUMP			2
P2	BLEED-OFF PUMP			1
P3	MAKE-UP PUMP			1
T1	RECIRCULATION TANK			1
T2	MAKE-UP TANK			1
T3	AERATOR			1
T4	NEUTRALIZATION TANK			1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000				
PARTICULATES, lb/hr				
SO_2, lb/hr				
TEMPERATURE, °F				
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm		600		2.0	10								
TOTAL SOLIDS, %													
pH		8.0		8.0									
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

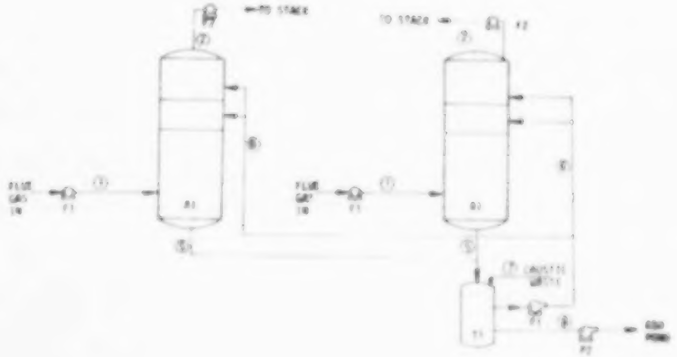


Figure 14-2. American Thread Co.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	10 DIA. x 12 HIGH	304SS, 316SS	2
F1	F.D. FAN	60 HP		2
F2	I.D. FAN	60 HP		2
P1	RECIRCULATION PUMP			
P2	WASTE PUMP			
T1	RECIRCULATION TANK	12 x 12 x 8 HIGH	3/8" C.S.	

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	60	41.2		
PARTICULATES, lb/hr				
SO_2, lb/hr				
TEMPERATURE, °F	400	130		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm													
TOTAL SOLIDS, %													
pH	2.5	8.5											
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

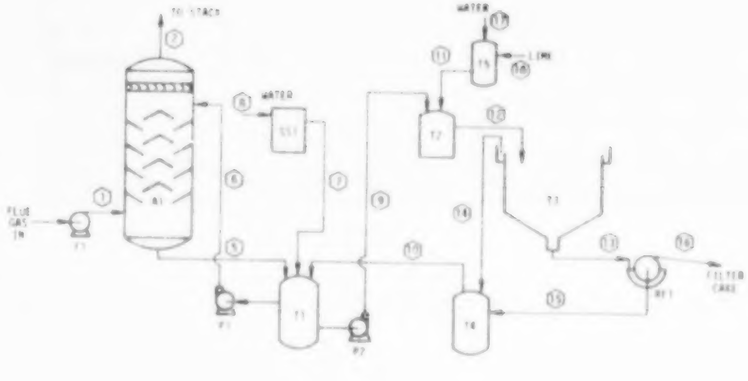

TO STACK
②
FLUE GAS IN
F1
①
A1
⑥
⑤
P1
WATER
⑧
SS1
⑦
T1
P2
⑨
⑩
⑪
T2
WATER
⑰
T5
LIME
⑱
⑫
⑭
T3
T4
⑬
⑯
RF1
FILTER CAKE
⑮

Figure 14-3. Arco/Polymers, Inc.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER			3
F1	F.D. FAN			3
M1	MIST ELIMINATOR			3
P1	RECIRCULATION PUMP			3
P2	LIME REACTOR PUMP			3
RF1	ROTARY VACUUM FILTER			1
SS1	SODA ASH STORAGE			
T1	RECIRCULATION TANK			3
T2	LIME REACTOR			3
T3	THICKENER			
T4	SURGE TANK			
T5	LIME SLAKER			1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000				
PARTICULATES, lb/hr				
SO_2, lb/hr				
TEMPERATURE, °F				
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm													
TOTAL SOLIDS, %													
pH													
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

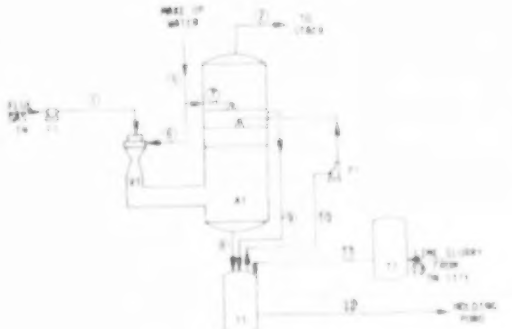

MAKE UP WATER
TO STACK
FLUE GAS
A1
V1
F1
P1
T1
T2
LIME SLURRY FROM
HOLDING POND
1
6
7
8
9
10
11
12

Figure 14-4. Armco Steel.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	17 DIA.	C.S., FIBERGLASS LINED TRAYS, 316L SS	1
F1	F.D. FAN			1
P1	RECIRCULATION PUMP		RUBBER-LINED C.S.	1
T1	RECIRCULATION TANK	10,000 GAL	RUBBER-LINED C.S.	1
T2	LIME SLURRY HOLD TANK			1
V1	VENTURI		316L SS	1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	140	83		
PARTICULATES, lb/hr		33		
SO_2, lb/hr				
TEMPERATURE, °F	425			
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm	1600			3200		1600	100	1600					
TOTAL SOLIDS, %													
pH						7.0							
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

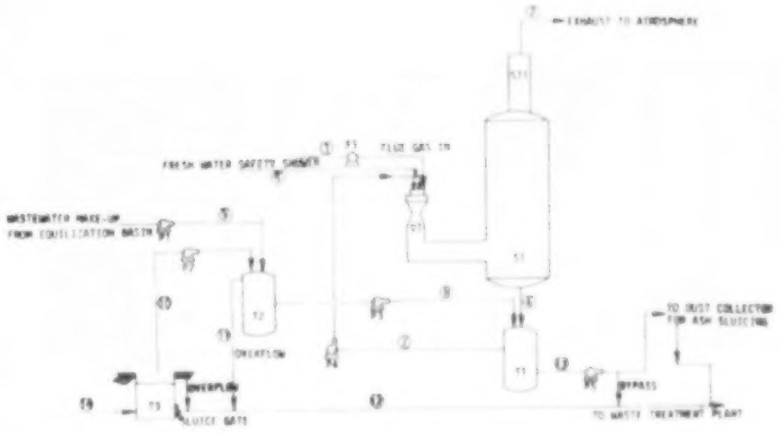

EXHAUST TO ATMOSPHERE
ST1
FLUE GAS IN
F1
FRESH WATER SAFETY SHOWER
WASTEWATER MAKE-UP FROM EQUILIZATION BASIN
S1
T2
T1
P4
OVERFLOW
SLUICE GATE
T3
TO DUST COLLECTOR FOR ASH SLUICING
BYPASS
TO WASTE TREATMENT PLANT

Figure 14-5. Canton Textiles.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	I.D. FAN			1
P1	MAKE-UP PUMP			1
P2	MAKE-UP PUMP			1
P3	MAKE-UP PUMP			1
P4	RECIRCULATION PUMP			1
P5	BLEED-OFF PUMP			1
S1	SEPARATOR		FIBERGLASS	1
ST1	STACK		FIBERGLASS	1
T1	RECIRCULATION TANK			1
T2	DYE RETENTION BASIN	14,979 GAL.		1
T3	DYE COLLECTION MANHOLE			1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	42			
PARTICULATES, lb/hr	295.2	29.5		
SO_2, lb/hr	124.2	37.3		
TEMPERATURE, °F	430			
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm			0-291	201	0-291				0-201				
TOTAL SOLIDS, %													
pH		7.5	10.4-12.0						8.0				
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l					152								
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

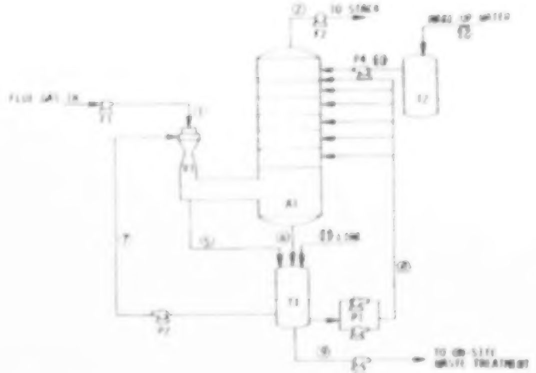

FLUE GAS IN
F1
①
V1
A1
②
TO STACK
F2
MAKE UP WATER
T2
P4
⑩
⑤
⑥
⑦
⑧
⑨
LIME
T1
P1
P2
P3
TO ON-SITE WASTE TREATMENT

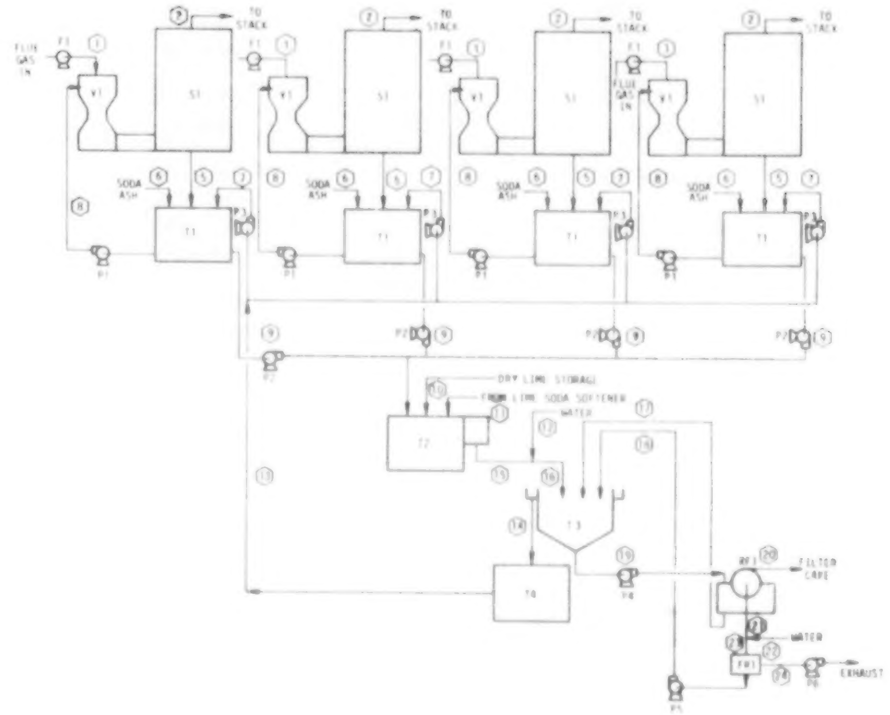
Figure 14-6. Carborundum Abrasives.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	8.5 DIA. x 38 HIGH	316L SS	1
F1	F.D. FAN			1
F2	I.D. FAN			1
P1	ABSORBER RECYCLE PUMPS			2
P2	VENTURI RECYCLE PUMPS			1
P3	BLEED-OFF PUMP			1
P4	MAKE-UP PUMP			1
T1	RECIRCULATION TANK			1
T2	MAKE-UP TANK			1
V1	VENTURI	4 INLET x 13 HIGH 13 IN. THROAT	316L SS, HASTALLOY W LINING	1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	45.8	33.1		
PARTICULATES, lb/hr				
SO_2, lb/hr	535.6	26.8		
TEMPERATURE, °F	350	125		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm				3000	30	45							
TOTAL SOLIDS, %					11								
pH	2.8												
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													


FLUE GAS IN
F1
V1
S1
TO STACK
SODA ASH
T1
P1
P2
P3
DRY LIME STORAGE
FROM LIME SODA SOFTENER
WATER
T2
T3
T4
P4
P5
P6
RF1
FILTER CAKE
FR1
EXHAUST

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN			4
FR1	FILTRATE RECEIVER			
P1	RECIRCULATION PUMPS			4
P2	LIME REACTOR PUMPS			
P3	FEED WATER PUMPS			
P4	UNDERFLOW PUMPS			
P5	REGENERATED LIQUOR PUMP			
P6	VACUUM PUMP			
RF1	ROTARY FILTER			
S1	SEPARATOR			4
T1	RECIRCULATION TANK			4
T2	LIME REACTOR TANK			
T3	THICKENER			
T4	SURGE TANK			
V1	VENTURI			4

Figure 14-7. Caterpillar Tractor Co., East Peoria.

(continued)

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	80			
PARTICULATES, lb/hr				
SO_2, lb/hr	1040	104		
TEMPERATURE, °F	150			
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100		7.1				28.5							
gpm													
TOTAL SOLIDS, %													
pH													
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

LIQUID STREAM NO.	⑱	⑲	⑳	㉑	㉒	㉓	㉔	㉕	㉖	㉗	㉘	㉙	㉚	㉛	㉜	㉝	㉞	㉟	㊱	㊲
RATE, lb/hr x 100			171.2																	
gpm																				
TOTAL SOLIDS, %			60																	
pH																				
TEMPERATURE, °F																				
H_2O, lb/hr																				
SULFITE, mg/l																				
SULFATE, mg/l																				
CHLORIDE, mg/l																				
SPECIFIC GRAVITY																				

Figure 14-7. (continued)

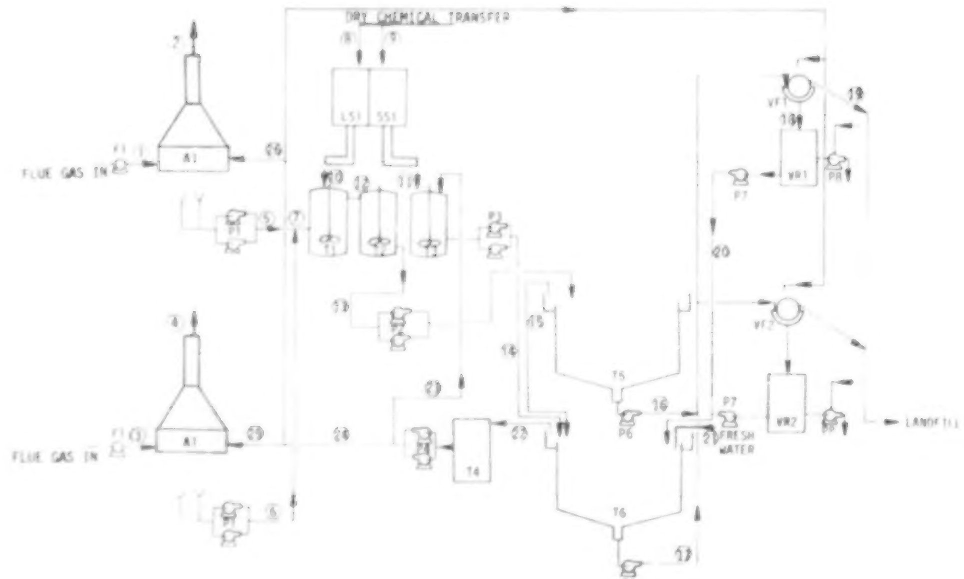

DRY CHEMICAL TRANSFER
FLUE GAS IN
FLUE GAS IN
F1
A1
A1
LS1
SS1
P1
P2
P3
T4
T5
T6
P6
P7
VF1
VF2
VR1
VR2
P8
FRESH WATER
LANDFILL

Figure 14-8. Caterpillar Tractor Co., Joliet.

(continued)

EQUIPMENT LIST

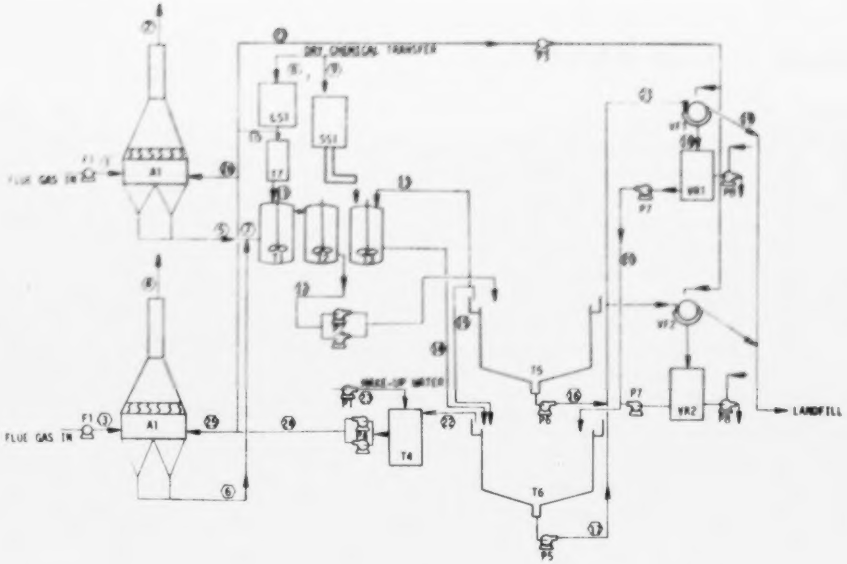
EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER		316 S.S.	2
F1	F.D. FAN			2
LS1	LIME STORAGE TANK		C.S.	1
P1	BLEED-OFF PUMPS			4
P2	LIME MIX TANK PUMPS			2
P3	SODA ASH MIX TANK PUMPS			2
P4	FEED WATER PUMPS			2
P5	SLUDGE PUMP			1
P6	SLUDGE PUMP			1
P7	FILTRATE PUMPS			2
P8	VACUUM PUMPS			2
SS1	SODA ASH STORAGE TANK		C.S.	1
T1	PRIMARY LIME MIX TANK		C.S.	1
T2	SECONDARY LIME MIX TANK		C.S.	1
T3	SODA ASH MIX TANK		C.S.	1
T4	SURGE TANK		C.S.	1
T5	THICKENER	50,000 GAL	C.S.	1
T6	CLARIFIER		C.S.	1
VF1	VACUUM FILTER		WET SURFACES 304 SS	1
VF2	VACUUM FILTER SPARE		WET SURFACES 304 SS	1
VR1	VACUUM RECEIVER		C.S.	1
VR2	VACUUM RECEIVER SPARE		C.S.	1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	57.5	41.9	46.0	33.2
PARTICULATES, lb/hr		22.9		15.0
SO_2, lb/hr	345.6	32.8	241.1	23.5
TEMPERATURE, °F	350	130	350	125
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100						10.4	2.9						
gpm													
TOTAL SOLIDS, %													
pH												15-20	15-20
TEMPERATURE, °F											12.0		
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

LIQUID STREAM NO.	⑱	⑲	⑳	㉑	㉒	㉓	㉔	㉕	㉖	㉗	㉘	㉙	㉚	㉛	㉜	㉝	㉞	㉟	㊱	㊲
RATE, lb/hr x 100		52.0																		
gpm				.6																
TOTAL SOLIDS, %		65																		
pH					12.0	12.0	12.0	12.0	12.0											
TEMPERATURE, °F																				
H_2O, lb/hr																				
SULFITE, mg/l																				
SULFATE, mg/l																				
CHLORIDE, mg/l																				
SPECIFIC GRAVITY																				

Figure 14-8. (continued)



FLUE GAS IN
F1
A1
DRY CHEMICAL TRANSFER
P3
LS1
SS1
T7
T1
T2
T3
MAKE-UP WATER
T4
T5
P6
T6
P5
VF1
VR1
P7
VF2
VR2
P8
LANDFILL

Figure 14-9. Caterpillar Tractor Co., Morton.

(continued)

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER		316 S.S.	2
F1	F.D. FAN			2
LS1	LIME STORAGE TANK		C.S.	1
P1	CITY WATER PUMP			1
P2	LIME MIX TANK PUMPS			2
P3	FILTER WASH PUMP			1
P4	FEED WATER PUMPS			2
P5	SLUDGE PUMP			2
P6	SLUDGE PUMP			2
P7	FILTRATE PUMPS			2
P8	VACUUM PUMPS			2
SS1	SODA ASH STORAGE TANK		C.S.	1
T1	PRIMARY LIME MIX TANK		C.S.	1
T2	SECONDARY LIME MIX TANK		C.S.	1
T3	SOFTENING TANK		C.S.	1
T4	SURGE TANK		C.S.	1
T5	THICKENER		C.S.	1
T6	CLARIFIER		C.S.	1
T7	MIX TANK			1
VF1	VACUUM FILTER		WET SURFACES 304 SS	1
VF2	VACUUM FILTER SPARE		WET SURFACES 304 SS	1
VR1	VACUUM RECEIVER		C.S.	1
VR2	VACUUM RECEIVER SPARE		C.S.	1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000	89.3	100.4	89.3	100.4
acfm x 1000	33.0	22.5	33.0	22.5
PARTICULATES, lb/hr	105.6	14.3	105.6	14.3
SO_2, lb/hr	379	28	379	28
TEMPERATURE, °F	410	134	410	134
H_2O, lb/hr	3900	15000	3900	15000
O_2, %		6.5		6.5
NO_x, lb/hr				
VELOCITY, ft/sec		77.7		77.7

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100				5.17	1.43			1351				44	
gpm	115	115	230				30	260			252	8	
TOTAL SOLIDS, %	2	2	2									15	
pH	6.0	6.0	6.0										
TEMPERATURE, °F	134	134	134	70	70								
H_2O, lb/hr													
SULFITE, mg/l	1500	1500	1500										600
SULFATE, mg/l	99840	99840	99840										96960
CHLORIDE, mg/l													
SPECIFIC GRAVITY	1.01	1.01	1.01					1.04	1.00	1.00		1.09	

LIQUID STREAM NO.	⑱	⑲	⑳	㉑	㉒	㉓	㉔	㉕	㉖	㉗	㉘	㉙	㉚	㉛	㉜	㉝	㉞	㉟	㊱	㊲
RATE, lb/hr x 100	80	66	24	66	1325	60	1385	633	633	10										
gpm	16	13.2	3.5	13.2	265	12	277	125	125	2.0										
TOTAL SOLIDS, %	15		50																	
pH	8.0	7.5	8.0	7.5		7.0	12.0	12.0	12.0	12.0										
TEMPERATURE, °F					70	70	70	70	70	70										
H_2O, lb/hr	6800	6600	1200	6600						1000										
SULFITE, mg/l							560	560	560											
SULFATE, mg/l							91200	91200	91200											
CHLORIDE, mg/l																				
SPECIFIC GRAVITY	1.09	1.00	1.38	1.00	1.00	1.00	1.00	1.00	1.00	1.00										

Figure 14-9. (continued)

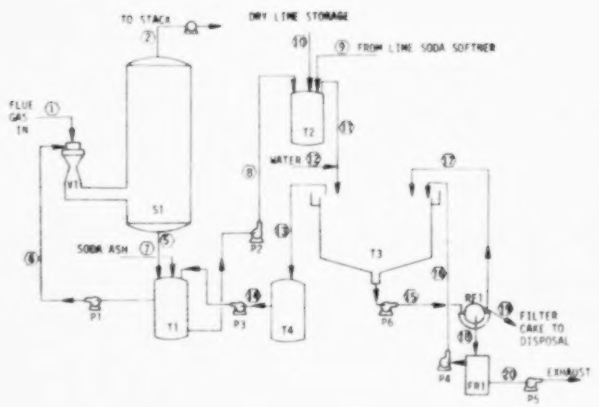

TO STACK
②
DRY LIME STORAGE
⑩
⑨ FROM LIME SODA SOFTNER
FLUE GAS IN
①
V1
S1
T2
⑪
WATER ⑫
⑧
⑰
⑬
P2
SODA ASH ⑦
⑤
⑥
T3
⑯
P1
T1
P3
⑭
T4
P6
⑮
RF1
⑲
FILTER CAKE TO DISPOSAL
⑱
P4
FR1
⑳
EXHAUST
P5

Figure 14-10. Caterpillar Tractor Co., Mossville.

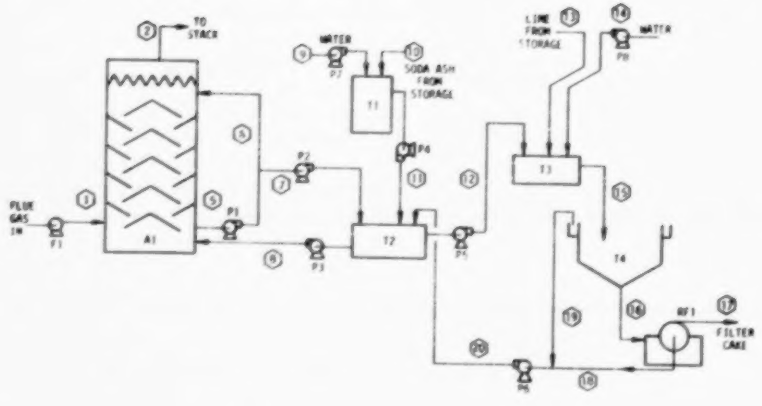
EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN			1
FR1	FILTRATE RECEIVER			1
P1	RECIRCULATION PUMP			
P2	BLEED-OFF PUMP			
P3	CAUSTIC PUMP			
P4	FILTRATE PUMP			
P5	EXHAUST PUMP			
P6	UNDERFLOW PUMP			
RF1	ROTARY FILTER			1
S1	SEPARATOR			4
T1	RECIRCULATION TANK			4
T2	LIME MIX TANK			
T3	THICKENER			
T4	SURGE TANK			
V1	VARIABLE THROAT VENTURI			4

Steam flow characteristics for Boiler No. 2 are from a final report on particulate and SO_2 emissions, January 21, 1977.

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	40	28.4		
PARTICULATES, lb/hr	604.8	10.5		
SO_2, lb/hr	440.1	23.4		
TEMPERATURE, °F	413	159		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰	⑱	⑲	⑳
RATE, lb/hr x 100			2.9			.2									23.5	
gpm		345														
TOTAL SOLIDS, %															60+	
pH		6.48		6.48			8.3		8.4							
TEMPERATURE, °F		130		130					120	130	130					
H_2O, lb/hr																
SULFITE, mg/l		24.2		24.2					13.7							
SULFATE, mg/l		86.9		86.9					70.8							
CHLORIDE, mg/l																
SPECIFIC GRAVITY		1.131		1.131					1.108							



FLUE GAS IN
F1
①
A1
②
TO STACK
⑤
P1
⑥
⑦
P2
⑧
P3
T2
⑨
WATER
P7
⑩
SODA ASH FROM STORAGE
T1
P4
⑪
⑫
P5
LIME FROM STORAGE
⑬
⑭
P8
WATER
T3
⑮
T4
⑯
RF1
⑰
FILTER CAKE
⑲
⑳
P6
⑱

Figure 14-11. Chanslor Western Oil & Dev. Co.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER			1
F1	F.D. FAN			8
P1	RECIRCULATION PUMP			
P2	BLEED-OFF PUMP			
P3	MAKE-UP LIQUOR PUMP			
P4	SODA ASH MAKE-UP PUMP			
P5	LIME REACTOR PUMP			
P6	CLARIFIED EFFLUENT PUMP			
P7	MAKE-UP WATER PUMP			
P8	MAKE-UP WATER PUMP			
RF1	ROTARY FILTER			1
T1	SODA ASH MAKE-UP			1
T2	RECIRCULATION TANK			1
T3	LIME REACTOR			1
T4	THICKENER			1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	133.4			
PARTICULATES, lb/hr				
SO_2, lb/hr	493.5	19.7		
TEMPERATURE, °F	550			
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm				71									
TOTAL SOLIDS, %													
pH													
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

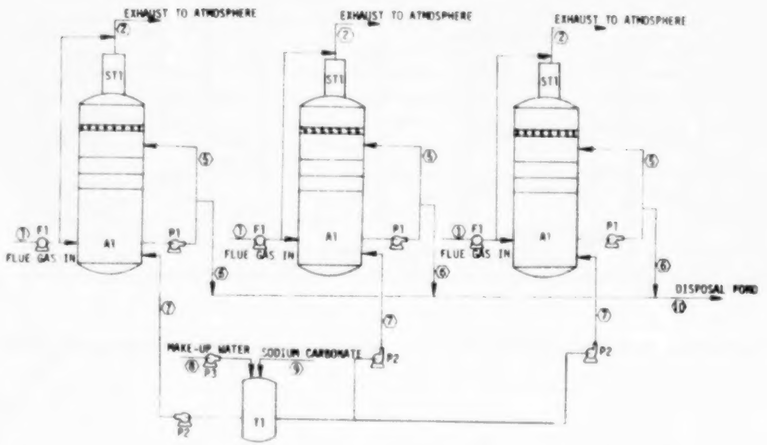

EXHAUST TO ATMOSPHERE
EXHAUST TO ATMOSPHERE
EXHAUST TO ATMOSPHERE
②
ST1
A1
①
F1
FLUE GAS IN
P1
⑤
⑥
⑦
DISPOSAL POND
⑩
MAKE-UP WATER
⑧
P3
SODIUM CARBONATE
⑨
P2
T1

Figure 14-12. Chevron U.S.A. Inc.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	16.5 DIA.	316L SS	3
F1	F.D. FAN			18
P1	RECIRCULATION PUMP			3
P2	MAKE-UP LIQUOR PUMP			
P3	MAKE-UP WATER PUMP			
ST1	STACK		316 SS	3
T1	MAKE-UP TANK			1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	150			
PARTICULATES, lb/hr				
SO_2, lb/hr	575.6	57.6		
TEMPERATURE, °F	500			
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm	750												
TOTAL SOLIDS, %													
pH	6.0-6.5												
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

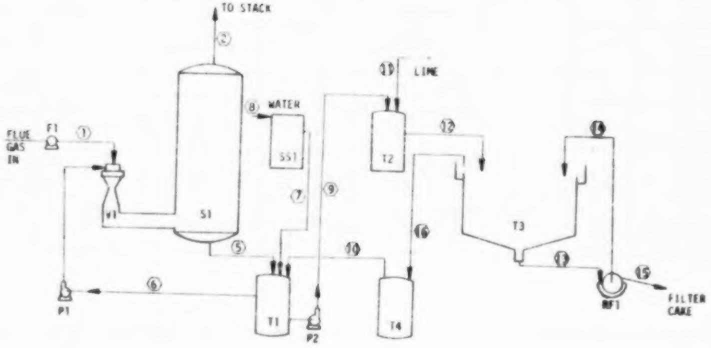

TO STACK
FLUE GAS IN
F1
①
②
V1
S1
③ WATER
SS1
⑦
⑨
⑤
⑥
P1
T1
P2
⑪ LIME
T2
⑫
⑩
⑯
T4
T3
⑭
⑬
⑮
RF1
FILTER CAKE

Figure 14-13. Firestone Tire and Rubber Co.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN			1
LS1	LIME STORAGE TANK			1
P1	RECIRCULATION PUMP		RUBBER-LINED CAST IRON	1
P2	LIME REACTOR PUMP		RUBBER-LINED CAST IRON	1
RF1	ROTARY FILTER		316L S.S.	1
S1	SEPARATOR	4.67 DIA x 7.17 HIGH	316L S.S.	1
SS1	SODA ASH STORAGE			1
T1	RECIRCULATION TANK		316L S.S.	1
T2	LIME REACTOR		C.S.	1
T3	THICKENER		C.S.	1
T4	SURGE TANK		C.S.	1
V1	DUAL THROAT VENTURI	.5-1.25 THROAT LENGTH	316L S.S.	1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	13	10		
PARTICULATES, lb/hr	450	11.7		
SO_2, lb/hr	360	34.2		
TEMPERATURE, °F	300	130		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100											1.8		
gpm		130	.083										
TOTAL SOLIDS, %											55		
pH													
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

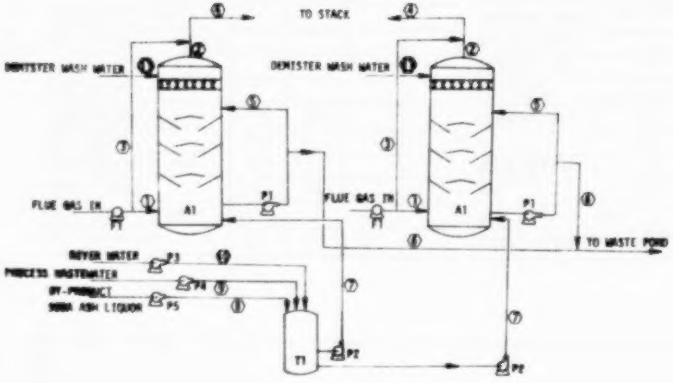

TO STACK
DEMISTER WASH WATER
DEMISTER WASH WATER
FLUE GAS IN
FLUE GAS IN
A1
A1
P1
P1
F1
F1
P2
P2
P3
P4
P5
T1
RIVER WATER
PROCESS WASTEWATER
BY-PRODUCT
SODA ASH LIQUOR
TO WASTE POND
①
②
③
④
⑤
⑦
⑧

Figure 14-14. FMC (Soda Ash Plant).

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER		C.S., CEILCOTE 130 LINING, OUTER TRAYS ARE INCONLOY 825	2
F1	F.D. FAN			2
P1	RECIRCULATION PUMP	6000 GPM	RUBBER-LINED	4
P2	MAKE-UP [illegible]			2
P3	RIVER WATER MAKE-UP PUMP			1
P4	PROCESS WASTEWATER MAKE-UP PUMP			1
P5	SODA-ASH LIQUOR PUMP			1
T1	MAKE-UP TANK			

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	231	176	99	279
PARTICULATES, lb/hr				
SO_2, lb/hr				
TEMPERATURE, °F	320	135	320	200
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm	6800		300-400										
TOTAL SOLIDS, %													
pH	6.5	6.5	6.5										
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

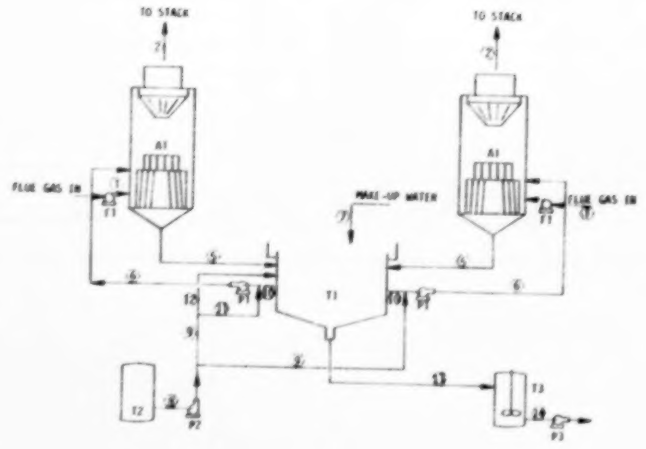

TO STACK
2
TO STACK
2
A1
A1
FLUE GAS IN
1
F1
FLUE GAS IN
1
F1
MAKE-UP WATER
7
5
6
5
6
P1
P1
T1
10
11
12
9
8
13
T2
P2
T3
14
P3

Figure 14-15. General Motors Corporation, Dayton.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	6 DIA. x 10 HIGH	316L SS	2
F1	F.D. FAN	35,000 SCFM, 9 IN. W.G.	C.S.	2
P1	RECIRCULATION PUMP	200 GPM, 25 HEAD	RUBBER-LINED C.S.	3
P2	CAUSTIC PUMP	80 GPM	C.S.	1
P3	BLEED-OFF PUMP	50 GPM	RUBBER-LINED C.S.	2
T1	RECIRCULATION TANK	7.5 DIA. x 12 HIGH	316L SS	1
T2	CAUSTIC TANK	9 DIA. x 18 HIGH	C.S.	1
T3	BLEED-OFF TANK	6 DIA. x 6.5 HIGH	316L SS	1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	45	35.6		
PARTICULATES, lb/hr	55.3	8.3		
SO_2, lb/hr	111.5	16.4		
TEMPERATURE, °F	400	125		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm	50	200	50						35	35			
TOTAL SOLIDS, %										50			
pH		7.0											
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

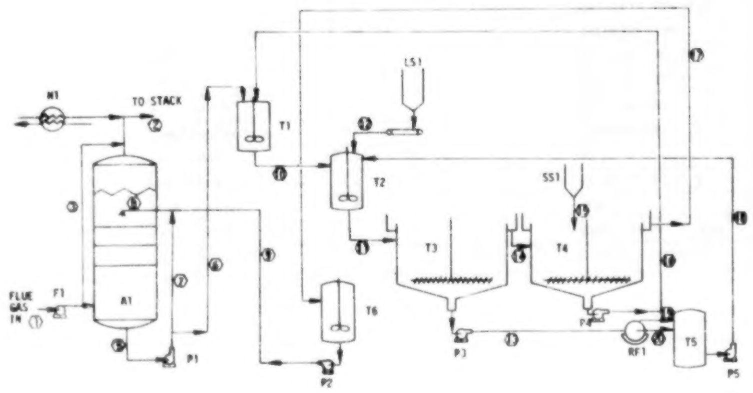


Figure 14-16. General Motors Corporation, Parma.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	10.5 DIA. x 22.5 HIGH	316L SS	4
F1	F.D. FAN	200 HP, 12 IN. W.G.	C.S.	4
H1	REHEATER			4
P1	RECIRCULATION PUMP	2-750 GPM 2-550 GPM	C.S., RUBBER-LINED	4
P2	RECIRCULATION PUMP	700 GPM	RUBBER-LINED	3
P3	UNDERFLOW PUMP	100 GPM	RUBBER-LINED	2
P4	UNDERFLOW PUMP	25 GPM	RUBBER-LINED	2
P5	FILTRATE PUMP	300 GPM	RUBBER-LINED	2
RF1	ROTARY VACUUM FILTER	500 SQ. FT. AREA	C.S., POLYPROPYLENE CLOTH	2
LS1	LIME STORAGE	90 TON	C.S.	2
SS1	SODA ASH STORAGE	35 TON	C.S.	1
T1	CHEMICAL MIX TANK	5000 GAL	C.S.	1
T2	CHEMICAL MIX TANK	5000 GAL	C.S.	2
T3	CLARIFIER #1	60 DIA. x 14 HIGH		1
T4	CLARIFIER #2	60 DIA. x 14 HIGH		1
T5	FILTRATE TANK	4 DIA. x 7 HIGH	C.S.	1
T6	RECIRCULATION TANK	2-3700 GAL 2-3000 GAL	C.S., TAR COATING	4

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	58.6	35.5		
PARTICULATES, lb/hr	73.2	60.8		
SO_2, lb/hr	244-397	41.5		
TEMPERATURE, °F	550	152		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰	⑱	⑲	⑳	㉑
RATE, lb/hr x 100																	
gpm								1200									
TOTAL SOLIDS, %										15-20						50	
pH																	
TEMPERATURE, °F																	
H_2O, lb/hr																	
SULFITE, mg/l																	
SULFATE, mg/l																	
CHLORIDE, mg/l																	
SPECIFIC GRAVITY																	

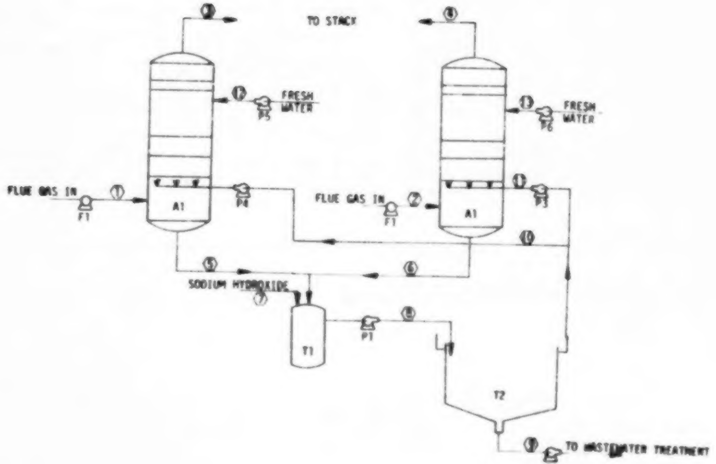

TO STACK
FRESH WATER
FRESH WATER
FLUE GAS IN
FLUE GAS IN
A1
A1
F1
F1
P1
P2
P3
P4
P5
P6
T1
T2
SODIUM HYDROXIDE
TO WASTEWATER TREATMENT
①
②
③
④
⑤
⑥
⑦
⑧
⑨
⑩
⑪
⑫
⑬

Figure 14-17. General Motors Corporation, Pontiac.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	12 DIA. x 21.5 HIGH	316L SS	2
F1	I.D. FAN			2
P1	RECIRCULATION PUMP			
P2	UNDERFLOW PUMP			
P3	RECIRCULATION PUMP			
P4	RECIRCULATION PUMP			
P5	MAKE-UP PUMP			
P6	MAKE-UP PUMP			
T1	HOLDING TANK			
T2	CLARIFIER			

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	91	75		
PARTICULATES, lb/hr	85.5	28.2		
SO_2, lb/hr				
TEMPERATURE, °F	360	360		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm					10-20	405	325	50	50				
TOTAL SOLIDS, %					5.0								
pH													
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

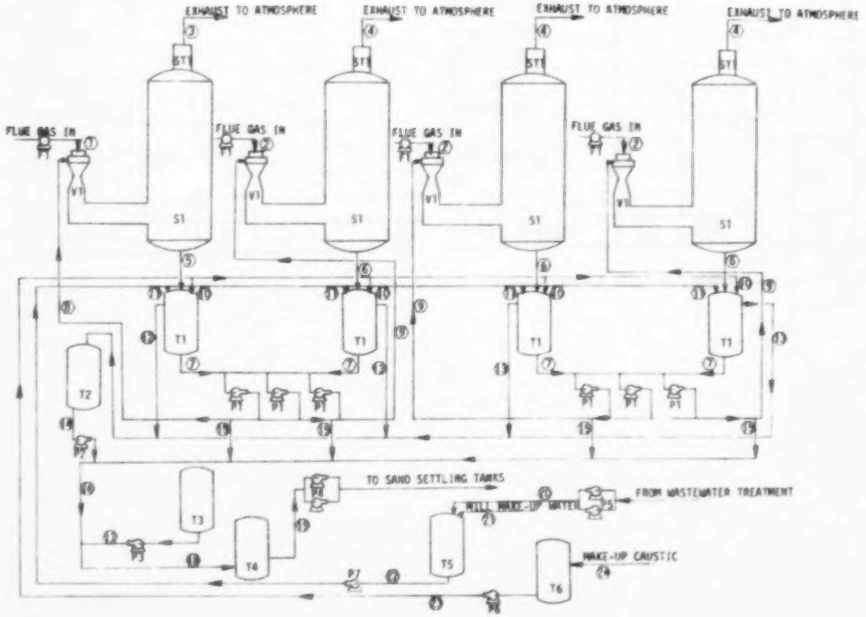

EXHAUST TO ATMOSPHERE
EXHAUST TO ATMOSPHERE
EXHAUST TO ATMOSPHERE
EXHAUST TO ATMOSPHERE
FLUE GAS IN
FLUE GAS IN
FLUE GAS IN
FLUE GAS IN
ST1
S1
V1
T1
T2
T3
T4
T5
T6
P1
P2
P3
P4
P5
P6
P7
TO SAND SETTLING TANKS
MILL MAKE-UP WATER
FROM WASTEWATER TREATMENT
MAKE-UP CAUSTIC

Figure 14-18. General Motors Corporation, Tonowanda.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	I.D. FAN			4
P1	RECIRCULATION PUMPS			6
P2	OVERFLOW PUMP			1
P3	CHEMICAL FEED PUMPS			1
P4	SCRUBBER BLOW-DOWN PUMPS			2
P5	WASTE TREATMENT TRANSFER PUMPS			2
P6	CAUSTIC FEED PUMPS			1
P7	MAKE-UP PUMP			1
S1	SEPARATOR		316L SS	4
ST1	STACK		S.S.	4
T1	RECYCLE TANK			4
T2	OVERFLOW TANK			1
T3	CHEMICAL FEED TANK			1
T4	AERATION MIXER			1
T5	HOLDING TANK			1
T6	CAUSTIC STORAGE TANK			1
V1	VARIABLE THROAT VENTURI		316L SS	4

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	39.6	36.0		
PARTICULATES, lb/hr	130.0	104.0	11.0	10.4
SO_2, lb/hr	257.3	218.8	25.7	21.9
TEMPERATURE, °F	350	406		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	5	6	7	8	9	10	11	12	13	14	15	16	17
RATE, lb/hr x 100													
gpm				792	720						25-100		
TOTAL SOLIDS, %								<1.0	<1.0	<1.0	<1.0	<1.0	
pH	6.0	6.0	7.0	7.0	7.0								
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

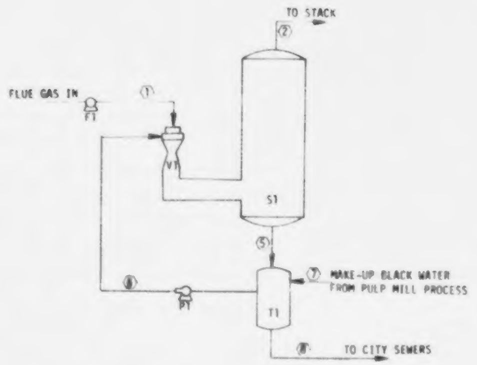

TO STACK
②
FLUE GAS IN
F1
①
V1
S1
⑤
⑦ MAKE-UP BLACK WATER FROM PULP MILL PROCESS
⑥
P1
T1
⑧
TO CITY SEWERS

Figure 14-19. Georgia-Pacific Paper Co.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN			1
P1	RECIRCULATION PUMP	5000 GPM	304SS RUBBER-LINED	1
S1	SEPARATOR	24 x 55 HIGH	304SS, FIBERGLASS LINED	1
T1	RECIRCULATION TANK		304SS	1
V1	VENTURI	9.5 WIDE x 30 HIGH	304SS	1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	320			
PARTICULATES, lb/hr	765	50		
SO_2, lb/hr	1094	109-164		
TEMPERATURE, °F	310			
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm		5000	2300	2000									
TOTAL SOLIDS, %													
pH				7.5									
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

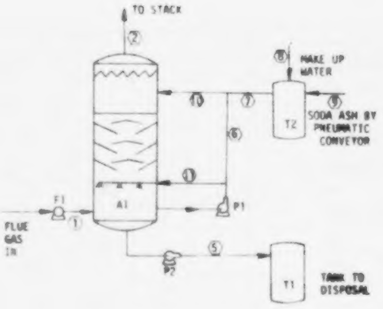

TO STACK
②
⑧ MAKE UP WATER
⑩
⑦
⑨
T2
SODA ASH BY PNEUMATIC CONVEYOR
⑥
①
F1
A1
P1
FLUE GAS IN
①
⑤
P2
T1
TANK TO DISPOSAL

Figure 14-20. Getty Oil Company.

EQUIPMENT LIST

FQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	13.5 DIA. x 35 HIGH	316L SS	1
F1	F.D. FAN			1
P1	RECIRCULATION PUMP			1
T1	DISPOSAL TANK			1
T2	SODA ASH MIX TANK	42,000 GAL	1/4" C.S.	1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	130	82.6		
PARTICULATES, lb/hr				
SO_2, lb/hr				
TEMPERATURE, °F	500	150		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm	10	1000											
TOTAL SOLIDS, %													
pH		6.8											
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

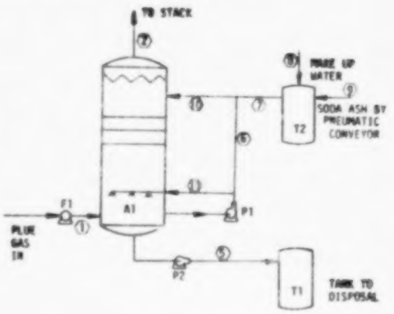

TO STACK
②
MAKE UP WATER
⑧
⑨
SODA ASH BY PNEUMATIC CONVEYOR
⑩
⑦
T2
⑥
⑪
F1
A1
P1
FLUE GAS IN
①
⑤
P2
T1
TANK TO DISPOSAL

Figure 14-21. Getty Oil Company.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	18 DIA. X 33 HIGH	316L SS	9
F1	F.D. FAN	500 HP, 11 IN. WG	C.S.	9
P1	RECIRCULATION PUMP	40 HP, 1000 GPM	C.S., RUBBER-LINED	9
P2	BLEED-OFF PUMP	40 HP, 1-2 GPM	316L SS RUBBER-LINED	9
T1	DISPOSAL TANK		C.S., RUBBER-LINED	9
T2	SODA ASH MIX TANK	20 DIA. X 20 HIGH 42,000 GAL.	C.S.	1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	200	127		
PARTICULATES, lb/hr				
SO_2, lb/hr				
TEMPERATURE, °F	500	150		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm	10	1000					150						
TOTAL SOLIDS, %													
pH		6.5-6.8											
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY		1.15											

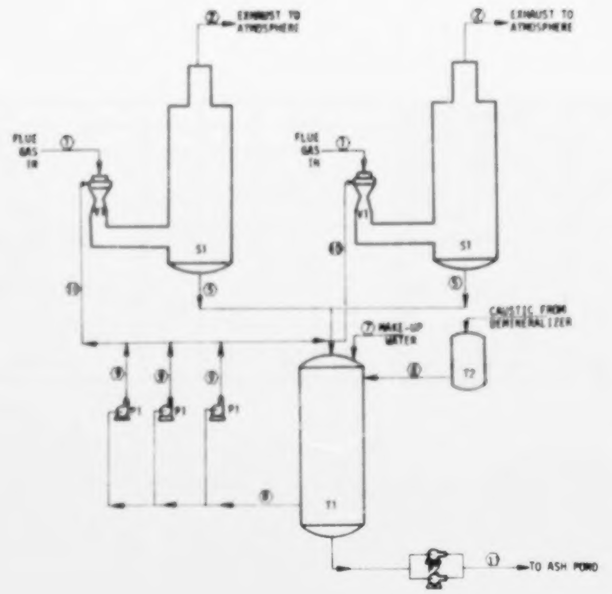

② EXHAUST TO ATMOSPHERE
② EXHAUST TO ATMOSPHERE
FLUE GAS IN ①
FLUE GAS IN ①
V1
V1
S1
S1
⑤
⑤
⑩
⑪
CAUSTIC FROM DEMINERALIZER
⑦ MAKE-UP WATER
⑨
⑨
⑨
P1
P1
P1
T2
⑧
T1
⑪ TO ASH POND

Figure 14-22. Great Southern Paper Co.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
P1	RECIRCULATION PUMP	2400 gpm	RUBBER-LINED	3
P2	ASH PUMP	500 gpm	RUBBER-LINED	2
S1	SEPARATOR		SS	2
T1	RECIRCULATION TANK		SS	1
T2	HOLD TANK			1
V1	VENTURI		SS	2

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	350	233		
PARTICULATES, lb/hr	6900	85		
SO_2, lb/hr	2500	250		
TEMPERATURE, °F	425	130		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm		350-400		3200	1600	1600	600						
TOTAL SOLIDS, %				2-5	2-5	2-5	6-8						
pH				3.5-5	3.5-5	3.5-5	3.5-5						
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

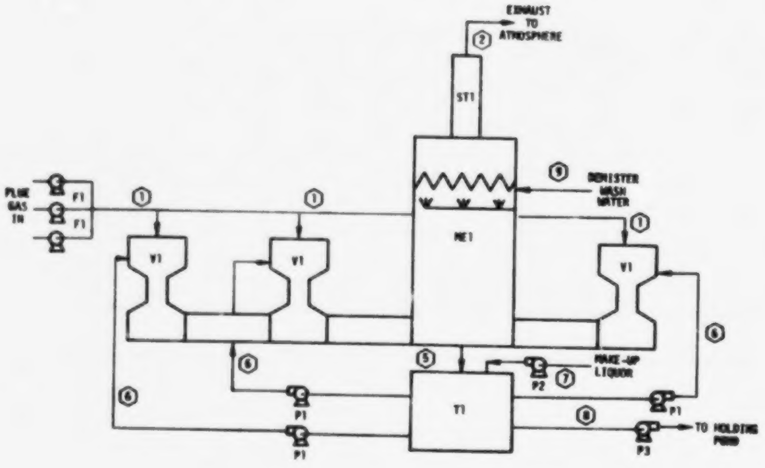

EXHAUST TO ATMOSPHERE
②
ST1
⑨
DEMISTER WASH WATER
FLUE GAS IN
F1
F1
①
①
①
ME1
V1
V1
V1
⑥
⑤
MAKE-UP LIQUOR
P2
⑦
⑥
⑥
T1
P1
P1
P1
⑧
P3
TO HOLDING POND

Figure 14-23. Great Western Sugar, Billings.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN			3
ME1	MIST ELIMINATOR			1
P1	RECIRCULATION PUMP			
P2	MAKE-UP PUMP			
P3	WASTEWATER PUMP			
ST1	STACK			1
T1	RECIRCULATION TANK			1
V1	VARIABLE THROAT VENTURI			3

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000				
PARTICULATES, lb/hr				
SO_2, lb/hr				
TEMPERATURE, °F				
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm													
TOTAL SOLIDS, %													
pH													
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

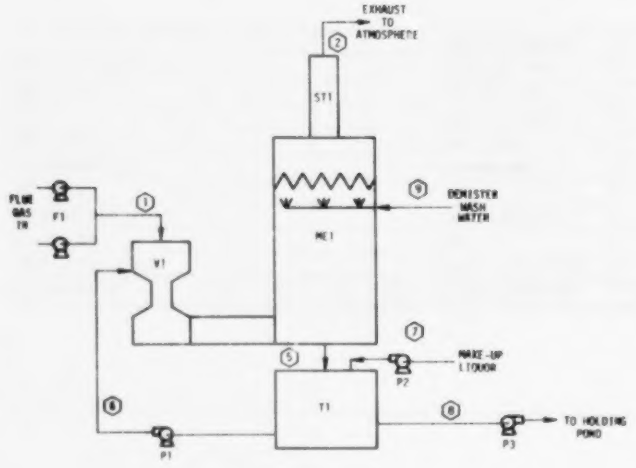

EXHAUST TO ATMOSPHERE
②
ST1
FLUE GAS IN
F1
①
V1
ME1
⑨
DEMISTER WASH WATER
⑦
MAKE-UP LIQUOR
P2
⑤
T1
⑥
P1
⑧
P3
TO HOLDING POND

Figure 14-24. Great Western Sugar, Findley.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN			2
ME1	MIST ELIMINATOR		SHELL-316L SS	1
P1	RECIRCULATION PUMP			
P2	MAKE-UP PUMP			
P3	WASTEWATER PUMP			
ST1	STACK	7.5 DIA		1
T1	RECIRCULATION TANK			
V1	VARIABLE THROAT VENTURI		316L SS	1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	120			
PARTICULATES, lb/hr				
SO_2, lb/hr	263.3	63.1		
TEMPERATURE, °F	515			
H_2O, lb/hr				
O_2,				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm		500	300	300	120								
TOTAL SOLIDS, %													
pH													
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

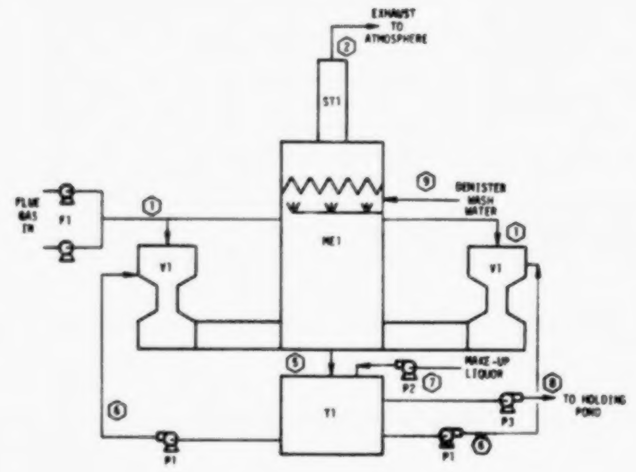

EXHAUST TO ATMOSPHERE
②
ST1
⑨
DEMISTER WASH WATER
FLUE GAS IN
F1
①
ME1
①
V1
V1
⑤
MAKE-UP LIQUOR
P2
⑦
⑧
TO HOLDING POND
P3
⑥
T1
P1
P1
⑥

Figure 14-25. Great Western Sugar, Fort Morgan.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN			2
ME1	MIST ELIMINATOR		SHELL-304L SS	1
P1	RECIRCULATION PUMP			
P2	WASTEWATER PUMP			
P3	MAKE-UP PUMP			
ST1	STACK	9.5 DIA. x 60 HIGH		
T1	RECIRCULATION TANK			
V1	VARIABLE THROAT VENTURI		316L SS	2

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	100	65.1		
PARTICULATES, lb/hr	728	34.7		
SO_2, lb/hr	266	267		
TEMPERATURE, °F	400	100		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm	1600+	800	1600	1600	120								
TOTAL SOLIDS, %													
pH													
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

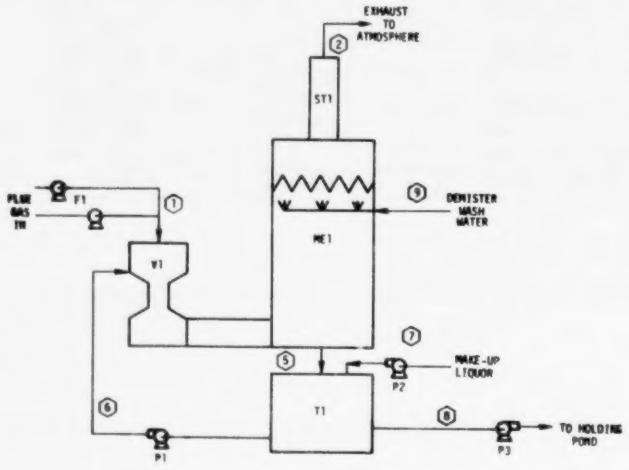

EXHAUST TO ATMOSPHERE
②
ST1
FLUE GAS IN
F1
①
V1
⑨
DEMISTER WASH WATER
ME1
⑦
⑤
MAKE-UP LIQUOR
P2
⑥
T1
⑧
P1
P3
TO HOLDING POND

Figure 14-26. Great Western Sugar, Freemont.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN			2
ME1	MIST ELIMINATOR			1
P1	RECIRCULATION PUMP			
P2	MAKE-UP PUMP			
P3	WASTEWATER PUMP			
ST1	STACK			1
T1	RECIRCULATION TANK			1
V1	VARIABLE THROAT VENTURI			1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000				
PARTICULATES, lb/hr				
SO_2, lb/hr				
TEMPERATURE, °F				
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm													
TOTAL SOLIDS, %													
pH													
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

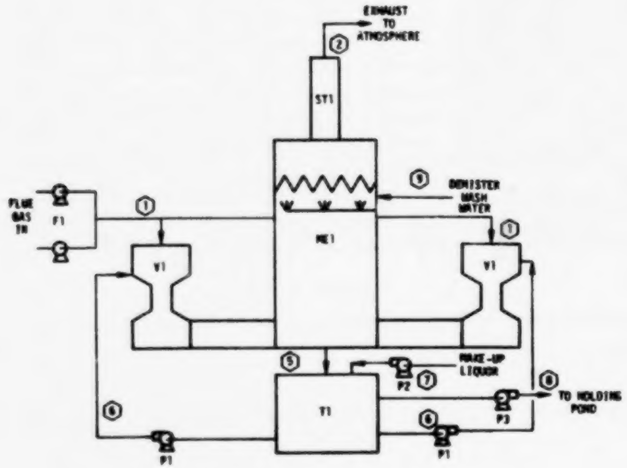

EXHAUST TO ATMOSPHERE
②
ST1
⑨
DEMISTER WASH WATER
FLUE GAS IN
F1
①
ME1
V1
V1
①
⑤
MAKE-UP LIQUOR
P2
⑦
⑧
TO HOLDING POND
P3
⑥
T1
⑥
P1
P1

Figure 14-27. Great Western Sugar, Gering.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN			2
ME1	MIST ELIMINATOR		SHELL 304L SS	1
P1	RECIRCULATION PUMP			
P2	MAKE-UP PUMP			
P3	WASTEWATER PUMP			
ST1	STACK	9 DIA.		1
T1	RECIRCULATION TANK			1
V1	VARIABLE THROAT VENTURI		304L SS	2

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	97			
PARTICULATES, lb/hr				
SO_2, lb/hr	336.6	101.0		
TEMPERATURE, °F	450			
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm		600	1400		150								
TOTAL SOLIDS, %													
pH													
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

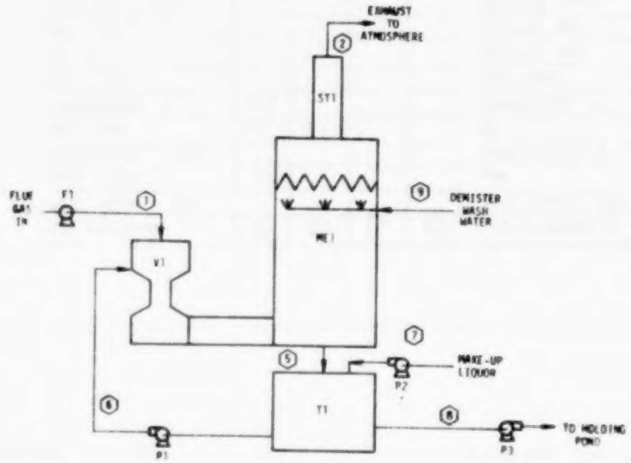

EXHAUST TO ATMOSPHERE
②
ST1
FLUE GAS IN
F1
①
⑨
DEMISTER WASH WATER
V1
ME1
⑦
MAKE-UP LIQUOR
⑤
P2
⑥
T1
⑧
TO HOLDING POND
P1
P3

Figure 14-28. Great Western Sugar, Greeley.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN			6
ME1	MIST ELIMINATOR		316 SS	1
P1	RECIRCULATION PUMP			
P2	MAKE-UP PUMP			
P3	WASTEWATER PUMP			
ST1	STACK			1
T1	RECIRCULATION TANK			1
V1	VARIABLE THROAT VENTURI		316L SS	1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	164.6			
PARTICULATES, lb/hr				
SO_2, lb/hr	343.1	223.0		
TEMPERATURE, °F	550			
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm	550+	1100	550	1100	120								
TOTAL SOLIDS, %													
pH													
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

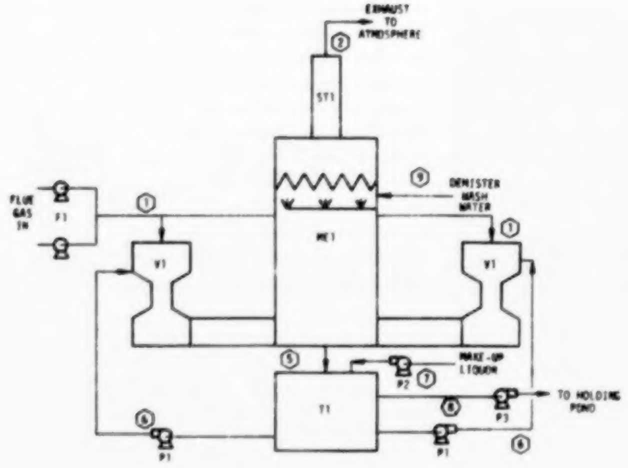

EXHAUST TO ATMOSPHERE
②
ST1
⑨
DEMISTER WASH WATER
FLUE GAS IN
F1
①
ME1
V1
①
V1
⑤
MAKE-UP LIQUOR
P2
⑦
T1
⑧
P3
TO HOLDING POND
⑥
P1
P1
⑥

Figure 14-29. Great Western Sugar, Loveland.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN			2
ME1	MIST ELIMINATOR		316L SS	1
P1	RECIRCULATION PUMP			
P2	MAKE-UP PUMP			
P3	WASTEWATER PUMP			
ST1	STACK	65 HIGH x 10.2 DIA.		1
T1	RECIRCULATION TANK			1
V1	VARIABLE THROAT VENTURI		316L SS	2

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	100	66.9		
PARTICULATES, lb/hr				
SO_2, lb/hr	160.1	227.1		
TEMPERATURE, °F	410	122		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm	1500+	800	750	1500	120								
TOTAL SOLIDS, %													
pH		8.7											
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

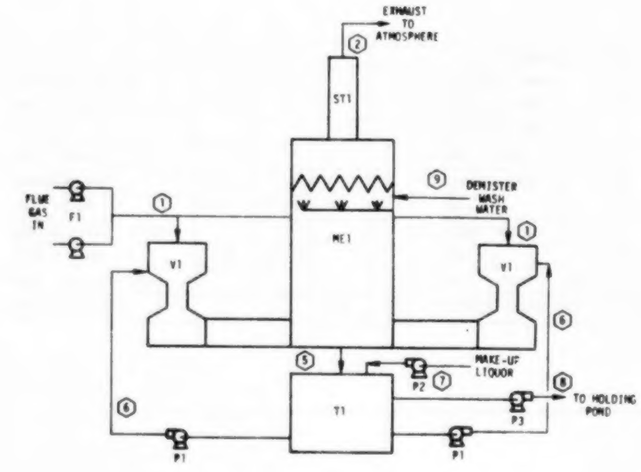

EXHAUST TO ATMOSPHERE
②
ST1
⑨
DEMISTER WASH WATER
FLUE GAS IN
F1
①
ME1
V1
①
V1
⑥
⑤
MAKE-UP LIQUOR
P2
⑦
⑧
TO HOLDING POND
P3
T1
⑥
P1
P1

Figure 14-30. Great Western Sugar, Scotts Bluff.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN			2
ME1	MIST ELIMINATOR		SHELL-304L SS	1
P1	RECIRCULATION PUMP			
P2	MAKE-UP PUMP			
P3	WASTEWATER PUMP			
ST1	STACK	10.5 DIA.		1
T1	RECIRCULATION TANK			1
V1	VARIABLE THROAT VENTURI		304L SS	2

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	130	88		
PARTICULATES, lb/hr				
SO_2, lb/hr	318.2	206.8		
TEMPERATURE, °F	400	122		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm	1600+		800	1650	150								
TOTAL SOLIDS, %													
pH													
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

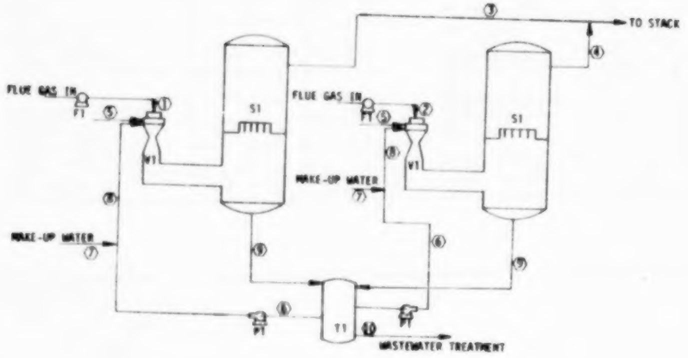

FLUE GAS IN
F1
①
⑤
V1
S1
⑧
MAKE-UP WATER
⑦
⑨
FLUE GAS IN
F1
⑤
②
③
TO STACK
④
V1
S1
⑧
MAKE-UP WATER
⑦
⑥
⑨
P1
⑥
T1
⑩
P1
WASTEWATER TREATMENT

Figure 14-31. ITT Rayonier, Inc.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN	1035 HP		2
P1	RECIRCULATION PUMP	75 HP	316 SS	2
S1	SEPARATOR	16.5 DIA. x 38 HIGH	316L SS	2
T1	RECIRCULATION TANK			1
V1	VARIABLE THROAT VENTURI		316L SS	2

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	165	140		
PARTICULATES, lb/hr	1300	1300	30	30
SO_2, lb/hr	1132.0	961.0	169.9	144.2
TEMPERATURE, °F	460	460		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm	180	1470	150	1620									
TOTAL SOLIDS, %													
pH													
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

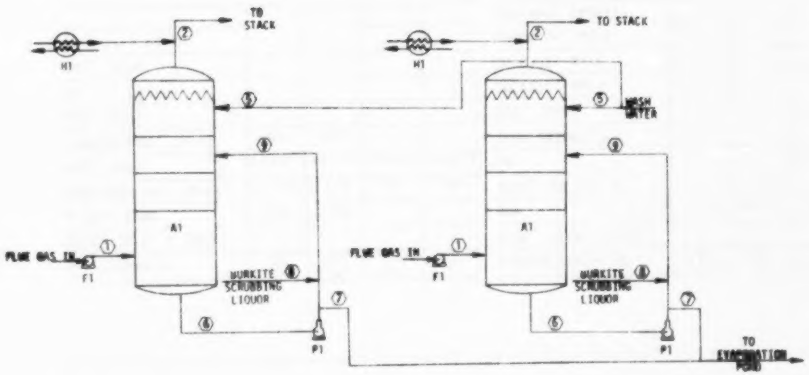

TO STACK
H1
②
⑤
⑨
A1
FLUE GAS IN
F1
①
WURKITE SCRUBBING LIQUOR
⑧
⑦
⑥
P1
TO STACK
H1
②
WASH WATER
⑤
⑨
A1
FLUE GAS IN
F1
①
WURKITE SCRUBBING LIQUOR
⑧
⑦
⑥
P1
TO EVAPORATION POND

Figure 14-32. Kerr-McGee Chemical Corp.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	30 DIA. x 35 HIGH	C.S., FIBERGLASS LINED, 316L SS TRAYS	2
F1	F.D. FAN		C.S.	2
H1	REHEATER	50°F REHEAT	C.S.	2
P1	RECIRCULATION PUMP	125 GPM	C.S., RUBBER-LINED	2

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	363	296		
PARTICULATES, lb/hr				
SO_2, lb/hr				
TEMPERATURE, °F	320	175		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm				125									
TOTAL SOLIDS, %													
pH			6.0-6.5	6.0-6.5	6.0-6.5								
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

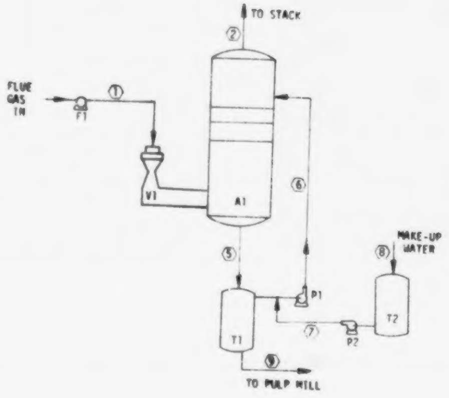

TO STACK
FLUE GAS IN
F1
①
②
V1
A1
⑥
⑤
MAKE-UP WATER
⑧
P1
T1
⑦
P2
T2
⑨
TO PULP MILL

Figure 14-33. Mead Paperboard Co.

EQUIPMENT LIST

EQ. NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER		316 SS	1
F1	F.D. FAN			1
P1	RECIRCULATION PUMP			1
P2	CAUSTIC PUMP			1
T1	RECIRCULATION TANK		FIBERGLASS	1
T2	SODIUM CARBONATE TANK			1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	175	115		
PARTICULATES, lb/hr				
SO_2, lb/hr				
TEMPERATURE, °F	450	140		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm	3000	600	20-25	20-25									
TOTAL SOLIDS, %													
pH			7.0-8.5										
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY	1.1-1.17												

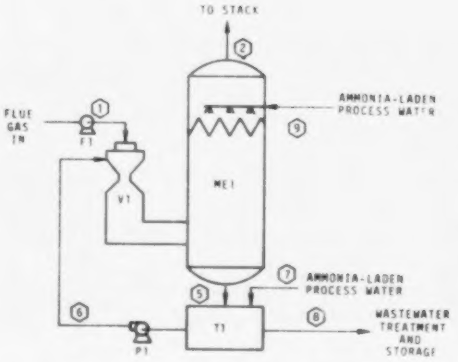

TO STACK
②
FLUE GAS IN
①
F1
V1
ME1
AMMONIA-LADEN PROCESS WATER
⑨
⑦ AMMONIA-LADEN PROCESS WATER
⑤
⑥
T1
P1
⑧
WASTEWATER TREATMENT AND STORAGE

Figure 14-34. Minn-Dak Farmer's Coop.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN			2
ME1	MIST ELIMINATOR		316SS	2
P1	RECIRCULATION PUMP	75 HP 3000 GPM		2
T1	RECIRCULATION TANK	10 x 10 x 10	CONCRETE PIT, TAR LINED	2
V1	VARIABLE THROAT VENTURI		316L SS	2

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	125			
PARTICULATES, lb/hr	245.4			
SO_2, lb/hr	76-193	10-37		
TEMPERATURE, °F	350			
H_2O, lb/hr		40.0		
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm	2000+	2000		486	250	500							
TOTAL SOLIDS, %													
pH	5.4	5.4		5.0		8.0							
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

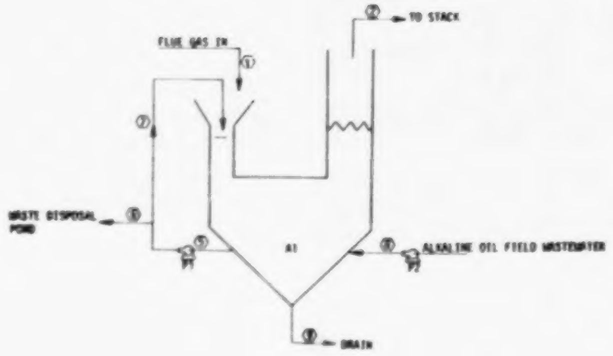

FLUE GAS IN
①
② TO STACK
⑦
WASTE DISPOSAL POND
⑥
⑤
P1
A1
⑧
ALKALINE OIL FIELD WASTEWATER
P2
⑨ DRAIN

Figure 14-35. Mobil Oil Company, Buttonwillow.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER		C.S., EPOXY COATED	7
P1	RECIRCULATION PUMP			7
P2	MAKE-UP PUMP			7

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	11.4			
PARTICULATES, lb/hr				
SO_2, lb/hr	30	4.5		
TEMPERATURE, °F	550			
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm				15									
TOTAL SOLIDS, %													
pH													
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

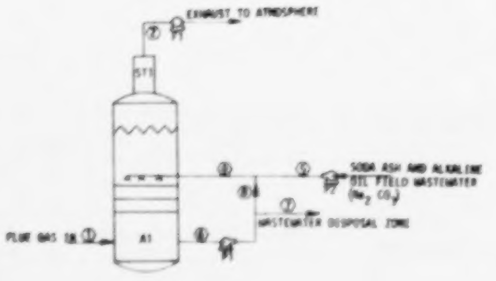

EXHAUST TO ATMOSPHERE
②
F1
ST1
A1
FLUE GAS IN ①
⑨
⑤
SODA ASH AND ALKALINE OIL FIELD WASTEWATER (Na_2CO_3)
P2
⑧
⑦
WASTEWATER DISPOSAL ZONE
⑥
P1

Figure 14-36. Mobil Oil Corp., San Ardo.

EQUIPMENT LIST SYSTEM 1

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBERS	4 DIA. x 20 HIGH	SHELL AND TRAYS 316L SS	20
F1	I.D. FANS		C.S., 316L SS LININGS ON CASINGS	20
P1	RECIRCULATION PUMPS			20
P2	MAKE-UP PUMPS			
ST1	STACKS		FIBERGLASS	20

EQUIPMENT LIST SYSTEM 2

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBERS	6.5 DIA. x 25 HIGH	SHELL AND TRAYS 316L SS	8
F1	I.D. FANS		C.S., 316L SS LININGS ON CASINGS	8
P1	RECIRCULATION PUMPS			8
P2	MAKE-UP PUMPS			8
ST1	STACKS		FIBERGLASS	8

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	8			
PARTICULATES, lb/hr				
SO_2, lb/hr	68	6.8		
TEMPERATURE, °F	470			
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm	75												
TOTAL SOLIDS, %													
pH		6.0	6.0	6.0	8.0								
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

STREAM FLOW CHARACTERISTICS FOR SYSTEM 1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	18			
PARTICULATES, lb/hr				
SO_2, lb/hr	153	15.3		
TEMPERATURE, °F	470			
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm	200												
TOTAL SOLIDS, %													
pH		6.0	6.0	6.0	8.0								
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

STREAM FLOW CHARACTERISTICS FOR SYSTEM 2

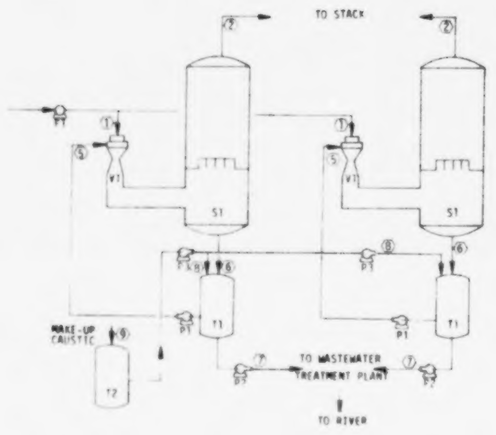

TO STACK
②
①
⑤
V1
S1
⑥
⑦
⑧
⑨
P1
P2
P3
F1
T1
T2
MAKE-UP CAUSTIC
TO WASTEWATER TREATMENT PLANT
TO RIVER

Figure 14-37. Nekoosa Papers, Inc.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN			2
P1	RECIRCULATION PUMP			
P2	BLEED-OFF PUMP			
P3	MAKE-UP PUMP			
S1	SEPARATOR			2
T1	RECIRCULATION TANK			
T2	MAKE-UP TANK			
V1	VARIABLE THROAT VENTURI			2

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	325			
PARTICULATES, lb/hr	2112	27		
SO_2, lb/hr	1259	126		
TEMPERATURE, °F	355			
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100	2.5				7.2								
gpm	50		150 250		400								
TOTAL SOLIDS, %													
pH	5.5-6.0												
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

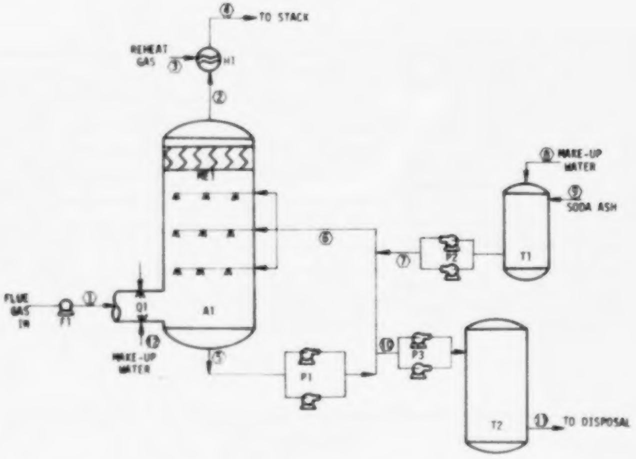

④ TO STACK
REHEAT GAS
③
H1
②
ME1
⑧ MAKE-UP WATER
⑨ SODA ASH
T1
⑥
⑦
P2
FLUE GAS IN
F1
①
Q1
A1
⑫ MAKE-UP WATER
⑤
P1
⑩
P3
T2
⑪ TO DISPOSAL

Figure 14-38. Phillip Morris, Inc.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	9 DIA X 35 HIGH	FRP	1
F1	F.D. FAN			1
H1	REHEATER			1
ME1	MIST ELIMINATOR		POLYPROPYLENE	1
P1	RECIRCULATION PUMP	1000 GPM	RUBBER-LINED	2
P2	MAKE-UP PUMP		RUBBER-LINED	2
P3	BLEED-OFF PUMP		RUBBER-LINED	2
Q1	PREQUENCHER	6 GPM		1
T1	SODA ASH TANK	12 DIA X 22 HIGH	C.S.	1
T2	AERATOR			1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	35	40		
PARTICULATES, lb/hr				
SO_2, lb/hr				
TEMPERATURE, °F	350	130	350	
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec	10	10		

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm	1000					5-11		6					
TOTAL SOLIDS, %													
pH	6.5	7.5				6.5							
TEMPERATURE, °F	130												
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

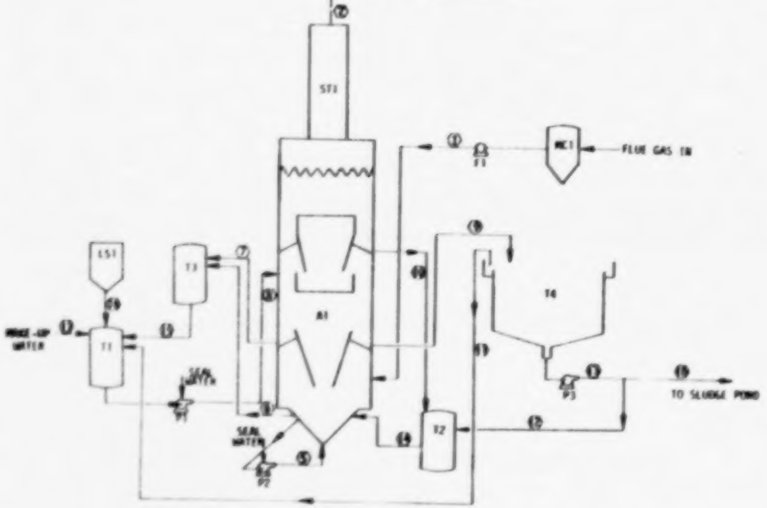

EXHAUST TO ATMOSPHERE
ST1
FLUE GAS IN
MC1
F1
A1
LS1
T3
MAKE-UP WATER
T1
SEAL WATER
P1
SEAL WATER
P2
T2
T4
P3
TO SLUDGE POND

Figure 14-39. Rickenbacker Air Force Base.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	12 DIA. x 61 HIGH	316L SS	1
F1	F.D. FAN	600 HP		1
LS1	LIME STORAGE	12 DIA. x 60 HIGH (120 TONS)	3/16" A-36 STEEL	1
MC1	MECHANICAL COLLECTOR			1
P1	RECIRCULATION PUMP		RUBBER-LINED	1
P2	RECIRCULATION PUMP		RUBBER-LINED	1
P3	UNDERFLOW PUMP		RUBBER-LINED	1
ST1	STACK	5.5 DIA. x 20 HIGH	FRP	1
T1	LIME MIX TANK		316L SS	1
T2	2ND STAGE LEVEL TANK			1
T3	1ST STAGE LEVEL TANK			1
T4	CLARIFIER	25 DIA.	WOOD	1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	100			
PARTICULATES, lb/hr	577.9	11.6		
SO_2, lb/hr	639.8	64.0		
TEMPERATURE, °F	475			
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰	⑱	⑲
RATE, lb/hr x 100															
gpm															
TOTAL SOLIDS, %				12.0				<40							
pH				5.5-6.0			4.8			5.5				8.5	
TEMPERATURE, °F															
H_2O, lb/hr															
SULFITE, mg/l															
SULFATE, mg/l															
CHLORIDE, mg/l															
SPECIFIC GRAVITY															

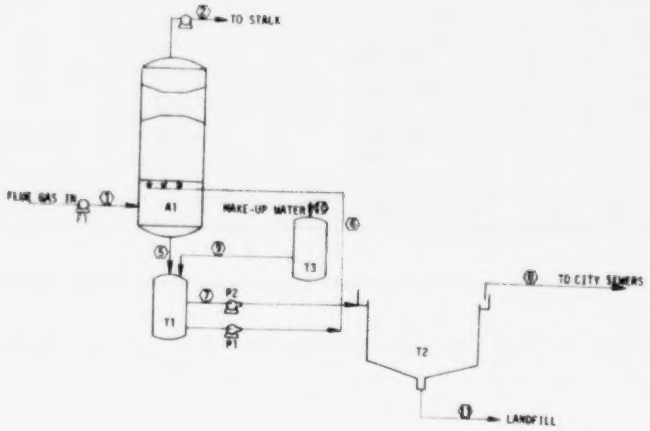

②
TO STALK
FLUE GAS IN
①
F1
A1
MAKE-UP WATER
⑩
⑥
⑤
⑨
T3
⑦
P2
T1
P1
T2
TO CITY SEWERS
LANDFILL

Figure 14-40. Sheller Globe Corp.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER		S.S.	1
F1	I.D. FAN			1
P1	RECIRCULATION PUMP		BRONZE	
P2	BLEED-OFF PUMP			
T1	RECIRCULATION TANK	20 x 10 x 8 HIGH	C.S.	1
T2	CLARIFIER			
T3	REAGENT MAKE-UP TANK			1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000				
PARTICULATES, lb/hr				
SO_2, lb/hr				
TEMPERATURE, °F				
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm													
TOTAL SOLIDS, %													
pH													
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

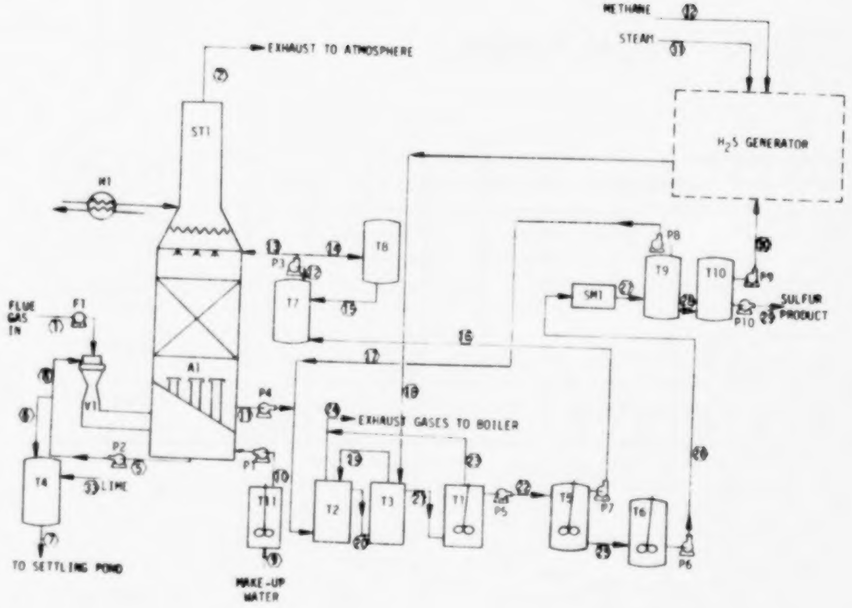

METHANE
STEAM
H$_2$S GENERATOR
EXHAUST TO ATMOSPHERE
ST1
H1
T8
T7
P3
FLUE GAS IN
F1
V1
A1
P4
P1
P2
LIME
T4
TO SETTLING POND
T11
MAKE-UP WATER
EXHAUST GASES TO BOILER
T2
T3
T1
P5
T5
P7
T6
P6
SM1
T9
P8
T10
P9
P10
SULFUR PRODUCT

Figure 14-41. St. Joe Zinc Co.

EQUIPMENT LIST

EQ NO	NAME	SIZE, FEET	MATERIAL	NO
A1	ABSORBER	26 I.D. x 85 HIGH	C.S., FLAKEGLASS LINED	1
F1	F.D. FAN	234,000 ACFM, 1000 HP		1
F2	FLOTATION AIR BLOWER (NOT SHOWN)	921 PSI, PRESSURE DIFFERENTIAL	C.S	2
H1	REHEATER			1
P1	MAKE-UP PUMP	100 GPM, 27 PSI, 5 HP	HASTELLOY	1
P2	SCRUBBER RECYCLE PUMP	4500 GPM, 118 PSI, 250 HP	RUBBER-LINED CAST IRON	4
P3	LEAN SOLUTION PUMP	120 HP	CHLORIMET 3	1
P4	RICH CITRATE SOLUTION PUMP	40 HP	CHLORIMET 3	1
P5	SULFUR SLURRY PUMP	64 GPM, 105 PSI, 20 HP	RUBBER-LINED HASTELLOY C	1
P6	SULFUR SLURRY PUMP	64 GPM, 105 PSI, 20 HP	RUBBER-LINED HASTELLOY C	1
P7	LEAN SOLUTION PUMP	120 HP	CHLORIMET 3	1
P8	RICH CITRATE SOLUTION PUMP	40 HP	CHLORIMET 3	1
P9	SULFUR TRANSFER PUMP	15 GPM, 72 PSI, 7.5 HP	CAST STEEL	1
P10	SULFUR LOADING PUMP	50 GPM, 20 PSI, 3 HP	CAST STEEL	1
SM1	SULFUR MELTER	4.11MM BTU/HR, ΔT=130°F	C.S. SHELL HASTELLOY TUBES C-276	1
ST1	STACK	10 I.D. x 102 HIGH		1
T1	DIGESTER	12 I.D. x 18 HIGH	C.S., FLAKEGLASS LINED	1
T2	SULFUR PRECIPITATION REACTOR	12.83 I.D. x 10.83 HIGH, 13,000 GAL	C.S., FLAKEGLASS LINED	1
T3	SULFUR PRECIPITATION REACTOR	12.83 I.D. x 10.83 HIGH, 13,000 GAL	C.S., FLAKEGLASS LINED	1
T4	LIME NEUTRALIZATION TANK			1
T5	SULFUR FLOTATION TANK	15 I.D. x 20 HIGH, 18,500 GAL	C.S., FLAKEGLASS LINED	1
T6	SULFUR SLURRY TANK	15 I.D. x 15 HIGH	C.S., FLAKEGLASS LINED	1
T7	CITRATE STORAGE TANK	20 I.D. x 30 HIGH	C.S., FLAKEGLASS LINED	1
T8	CRYSTALLIZER			1
T9	SULFUR DECANTER	65 PSIG @ 260°F	C.S., 1/8" HASTELLOY-C LINER	1
T10	STEAM HEATED SULFUR STORAGE TANK	20 I.D. x 24 HIGH, 56,000 GAL	C.S	1
T11	MAKE-UP TANK	5 I.D. x 7.5 HIGH	REINFORCED FIBERGLASS	1
T12	LEAN SOLUTION COOLER (NOT SHOWN)	5.0MM BTU/HR., 78 PSIG @ 131°F	PALLADIUM-STABILIZED TITANIUM	1
T13	VENTURI WASH WATER COOLER (NOT SHOWN)	19.0MM BTU/HR., 96 PSIG	PALLADIUM-STABILIZED TITANIUM	1
V1	VENTURI	10 DIA. x 45 HIGH	C.S., NOZZLE OF INCONEL 625, ACID PROOF BRICK LINED OVER RUBBER MEMBRANE	1
	H$_2$S GENERATOR	625 SCFM @ 45 PSIG, 300°F	S.S. SHELLS	1

(continued)

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	234	156		
PARTICULATES, lb/hr				
SO_2, lb/hr				
TEMPERATURE, °F	300	120		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm				16000	100				4200				
TOTAL SOLIDS, %													
pH								4.5	4.5	4.5			
TEMPERATURE, °F	120			112					123			121	120
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

LIQUID STREAM NO.	⑱	⑲	⑳	㉑	㉒	㉓	㉔	㉕	㉖	㉗	㉘	㉙	㉚	㉛	㉜	㉝	㉞	㉟	㊱	㊲
RATE, lb/hr x 100												12.9								
gpm			1300	1300				130	64	130		50	15							
TOTAL SOLIDS, %								10												
pH																				
TEMPERATURE, °F			131	131					131	260	260									
H_2O, lb/hr																				
SULFITE, mg/l																				
SULFATE, mg/l																				
CHLORIDE, mg/l																				
SPECIFIC GRAVITY																				

Figure 14-41. (continued)

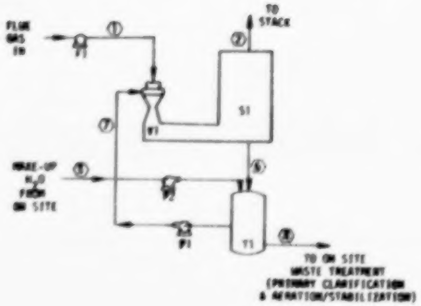

FLUE GAS IN
①
F1
TO STACK
②
S1
V1
⑦
MAKE-UP H2O FROM ON SITE
⑤
P2
⑥
P1
T1
⑧
TO ON SITE WASTE TREATMENT (PRIMARY CLARIFICATION & AERATION/STABILIZATION)

Figure 14-42. St. Regis Paper Co.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
F1	F.D. FAN			1
P1	RECIRCULATION PUMP			1
P2	MAKE-UP PUMP			1
S1	SEPARATOR		316L SS	1
T1	RECIRCULATION TANK	4000 GAL	304 SS	1
V1	VENTURI		316L SS	1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	175			
PARTICULATES, lb/hr	400	22		
SO_2, lb/hr				
TEMPERATURE, °F	425			
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm													
TOTAL SOLIDS, %	200-250												
pH	9.0												
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

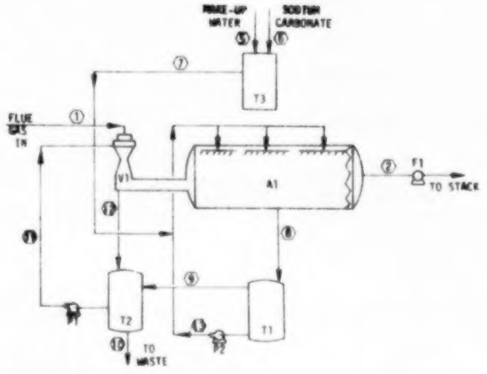

MAKE-UP WATER
SODIUM CARBONATE
⑤
⑥
⑦
T3
FLUE GAS IN
①
V1
A1
②
F1
TO STACK
⑫
⑪
⑧
⑨
T2
T1
P1
P2
⑬
⑩
TO WASTE

Figure 14-43. Texaco Inc., San Ardo.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	10 X 6 X 15 LONG	FIBERGLASS SHELL	3
F1	I.D. FAN	200 HP	FRP	6
P1	RECIRCULATION PUMP	40 HP, 1200 GPM	C.S., RUBBER-LINED	3
P2	RECIRCULATION PUMP	40 HP, 800 GPM	C.S., RUBBER-LINED	3
T1	ABSORBER RECYCLE TANK		C.S.	3
T2	VENTURI RECYCLE TANK		C.S.	3
T3	CARBONATE MIX TANK		C.S.	3
V1	VENTURI	12 X 22 X 9 LONG	316L SS	3

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	117	70		
PARTICULATES, lb/hr				
SO_2, lb/hr				
TEMPERATURE, °F	600	160		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm							1200		800				
TOTAL SOLIDS, %													
pH													
TEMPERATURE, °F													
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

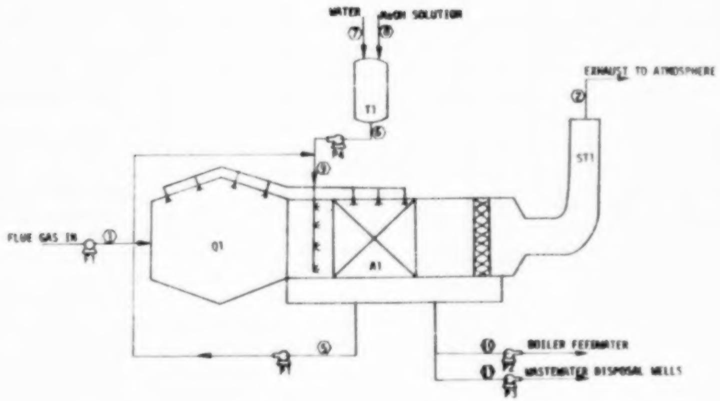

WATER
NaOH SOLUTION
⑦
⑧
T1
⑥
P4
③
EXHAUST TO ATMOSPHERE
②
ST1
FLUE GAS IN
①
Q1
A1
⑤
⑩
BOILER FEEDWATER
⑪
WASTEWATER DISPOSAL WELLS

Figure 14-44. Texaco, Inc., San Ardo.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBERS	7 X 8 X 12 2 IN. TELLERETTE PACKING	FRP POLYPROPYLENE	25
F1	I.D. FAN	40 HP, 10 IN. WG	C.S.	25
P1	RECIRCULATION PUMP			25
P2	BLEEDOFF PUMP			25
P3	WASTEWATER PUMP			25
P4	MAKE-UP PUMP	300 GPM		25
Q1	QUENCHER		316L SS	25
ST1	STACK		FRP	25
T1	MAKE-UP TANK		C.S.	1

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	26.0	15.2		
PARTICULATES, lb/hr				
SO_2, lb/hr	129	34.8		
TEMPERATURE, °F	600	160		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100													
gpm		300	150		150								
TOTAL SOLIDS, %													
pH		8.0	8.0	6.5	8.0	6.5	6.5						
TEMPERATURE, °F				160		160	160						
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

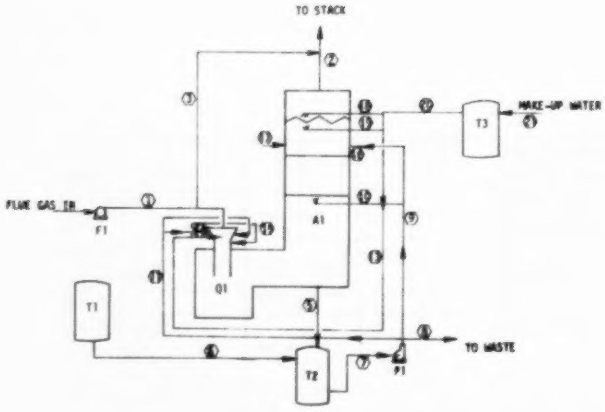


Figure 14-45. Texasgulf.

EQUIPMENT LIST

EQ NO.	NAME	SIZE, FEET	MATERIAL	NO.
A1	ABSORBER	15 DIA. x 20.5 HIGH	FLAKED GLASS LINED C.S. INCONEL 625 TRAYS	2
F1	F.D. FAN		C.S.	2
P1	RECIRCULATION PUMP	2400 GPM		4
Q1	QUENCHER		INCONEL 625	2
T1	LIQUOR HEAD TANK			2
T2	RECIRCULATION TANK			2
T3	HEAD TANK			2

GAS STREAM NO.	①	②	③	④
RATE, lb/hr x 1000				
acfm x 1000	156.1	121.6		
PARTICULATES, lb/hr				
SO_2, lb/hr				
TEMPERATURE, °F	350	120		
H_2O, lb/hr				
O_2, %				
NO_x, lb/hr				
VELOCITY, ft/sec				

LIQUID STREAM NO.	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰
RATE, lb/hr x 100		33.6-71.4		150-292									
gpm	1023				700	300	300		45-116	45-66	0-50	200	200
TOTAL SOLIDS, %		30											
pH													
TEMPERATURE, °F				120									
H_2O, lb/hr													
SULFITE, mg/l													
SULFATE, mg/l													
CHLORIDE, mg/l													
SPECIFIC GRAVITY													

LIQUID STREAM NO.	⑱	⑲	⑳	㉑	㉒	㉓	㉔	㉕	㉖	㉗	㉘	㉙	㉚	㉛	㉜	㉝	㉞	㉟	(36)	(37)
RATE, lb/hr x 100																				
gpm	100	15		60-93																
TOTAL SOLIDS, %																				
pH																				
TEMPERATURE, °F																				
H_2O, lb/hr																				
SULFITE, mg/l																				
SULFATE, mg/l																				
CHLORIDE, mg/l																				
SPECIFIC GRAVITY																				